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Glossary

Preparers

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Glossary

The glossary defines terms used throughout the document. If a term's definition(s) is associated with a particular species, management direction, or originates from a specific source, the source is cited or applicable direction is referenced with the following bracketed abbreviations:

- [GBCS] Grizzly Bear Conservation Strategy for the Northern Continental Divide Ecosystem (draft 2013, final in progress).
- [NCDE Food/Wildlife Attractant Storage Orders] one or more special orders related to occupancy and use restrictions for the Northern Continental Divide Ecosystem for grizzly bears
- [NRLMD] Northern Rockies Lynx Management Direction 2007
- [LCAS] Lynx Conservation and Assessment Strategy 2013
- [NWCG] National Wildfire Coordinating Group 2013

activity area a land area affected by a management activity to which soil quality standards are applied. An activity area must be feasible to monitor and includes harvest units within timber sale areas, prescribed burn areas, grazing areas or pastures within range allotments, riparian areas, recreation areas, and alpine areas. Temporary roads, skid trails, and landings are considered to be part of an activity area.

adaptive management the general framework encompassing the three phases of planning: assessment, plan development, and monitoring (36 CFR 219.5). This framework supports decision-making that meets management objectives while simultaneously accruing information to improve future management by adjusting the plan or plan implementation. Adaptive management is a structured, cyclical process for planning and decision-making in the face of uncertainty and changing conditions with feedback from monitoring, which includes using the planning process to actively test assumptions, track relevant conditions over time, and measure management effectiveness.

administrative site a location or facility constructed for use primarily by government employees to facilitate the administration and management of public lands. Examples on NFS lands include, but are not limited to, ranger stations, warehouses, and guard stations.

adfluvial migration of fish between lakes to rivers.

administrative use a generic term for authorized agency activity.

aerial retardant avoidance area mapped areas (interactive map online at https://www.fs.fed.us/fire/retardant/index.html) that are to be avoided during applications of fire retardant; including: habitat for threatened, endanger, proposed, candidate or sensitive species and all waterways. This national direction is mandatory and would be implemented except in cases where human life or public safety is threatened and retardant use within avoidance areas could be reasonably expected to alleviate that threat**.**

aircraft an airplane, helicopter, or other machine capable of flight.

airstrip an area of land that is used as a runway for aircraft to take off and land.

animal unit month the amount of dry forage required by one mature cow of approximately 1,000 pounds or its equivalent, for one month, based on a forage allowance of 26 pounds per day.

aquifer an underground layer of water-bearing permeable rock, rock fractures or unconsolidated material (gravel, sand or silt) from witch groundwater can be extracted using a water well.

aquatic organism passage provides the ability for fish and other aquatic creatures to move up and downstream under a road.

attractant a nourishing substance, which includes human food or drink (canned, solid or liquid), livestock feed (except baled or cubed hay without additives), pet food, and garbage. (Northern Continental Divide Ecosystem Food/Wildlife Attractant Storage Order).

alpine high elevation ecosystem dominated by grasses and low-lying shrubs.

baseline the environmental conditions at a specific point in time.

best management practice the method(s), measure(s), or practice(s) selected by an agency to meet its nonpoint source control needs. Best management practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Best management practices can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (36 Code of Federal Regulations 219.19).

biodiversity the variety and abundance of plants, animals, and other living organisms and the ecosystem processes, functions, and structures that sustain them. Biodiversity includes the relative complexity of species and communities across the landscape at a variety of scales, connected in a way that provides for the genetic diversity to sustain species over the long-term.

biological soil crust are a complex mosaic of cyanobacteria, green algae, lichens, mosses, microfungi, and other bacteria occurring on the soil surface in open spaces within arid and semiarid systems.

biophysical settings a grouping of potential vegetation types based on broad climatic and site conditions, such as temperature and moisture gradients. Also see potential vegetation types.

board foot a unit of measurement represented by a board one foot square and one inch thick.

boreal forest (lynx) a forest type to which lynx and snowshoe hares are strongly associated. The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (Picea spp.) and fir (Abies spp.) (USFWS Critical Habitat Final Rule 2009).

broadcast burn a management treatment where a prescribed fire is allowed to burn over a designated area within well-defined boundaries. A broadcast burn is used for reduction of fuel hazard, as a resource management treatment, or both.

candidate species a status (1) for USFWS candidate species, a species for which the U.S. Fish and Wildlife Service possesses sufficient information on vulnerability and threats to support a proposal to list as endangered or threatened, but for which no proposed rule has yet been published by the U.S. Fish and Wildlife Service; (2) for National Marine Fisheries Service candidate species, a species that is: (i) the subject of a petition to list and for which the National Marine Fisheries Service has determined that listing may be warranted, pursuant to section 4(b)(3)(A) of the Endangered Species Act (16 United States Code (U.S.C.) 1533(b)(3)(A)), or (ii) not the subject of a petition but for which the National Marine Fisheries Service has announced in the Federal Register the initiation of a status review.

canopy the forest cover of branches and foliage formed by tree crowns.

canopy base height the lowest height above the ground at which there is a sufficient amount of canopy fuel to propagate fire vertically into the canopy; canopy base height is an effective value that incorporates ladder fuels such as shrubs and understory trees.

canopy fuel the live and dead foliage, live and dead branches, and lichen of trees and tall shrubs that lie above the surface fuels.

capability the potential of an area of land and/or water to produce resources, supply goods and services, and allow resource uses under a specified set of management practices and at a given level of management intensity. Capability depends upon current conditions and site conditions (climate, slope, landform, soils, and geology), as well as the application of management practices (silviculture systems, or protection from fires, insects, and disease).

carbon pool an area that contains an accumulation of carbon or carbon-bearing compounds or having the potential to accumulate such substances. May include live and dead material, soil material, and harvested wood products.

carbon stock the amount or quantity contained in the inventory of a carbon pool.

clearcut a harvest technique: 1) a stand in which essentially all trees have been removed in one operation. Note: depending on management objectives, a clearcut may or may not have reserve trees left to attain goals other than regeneration. 2). A regeneration or harvest method that removes essentially all trees in a stand (synonym is clearcutting). Also see regeneration method.

climate change adaptation an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. This adaption includes initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Adaptation strategies include the following: building resistance to climate-related stressors; increasing ecosystem resilience by minimizing the severity of climate change impacts, reducing the vulnerability and/or increasing the adaptive capacity of ecosystem elements; facilitating ecological transitions in response to changing environmental conditions.

climax the final stage of succession in a plant community. A relatively stable condition where plant species on the site are able to perpetuate themselves indefinitely in the absence of disturbance.

coarse woody debris a piece or pieces of larger sized dead woody material (for example, dead boles, limbs, and large root masses) on the ground or in streams. Minimum size to be defined as “coarse” is generally 3 inches diameter.

commercial thinning a treatment that selectively removes trees large enough to be sold as products, such as sawlogs, poles or fence posts, from an overstocked stand. This treatment is usually carried out to improve the health and growth rate of the remaining crop trees, or to reduce fire hazard.

commercial use/activity a use or activity on NFS lands (a) where an entry or participation fee is charged, or (b) where the primary purpose is the sale of a good or service, and in either case, regardless of whether the use or activity is intended to produce a profit (36 Code of Federal Regulations 251.51).

community wildfire protection plans are strategic plans developed by communities to address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection—or all of the above. The Healthy Forests Restoration Act (HFRA) in 2003 includes statutory incentives for the US Forest Service (USFS) and the Bureau of Land Management (BLM) to give consideration to the priorities of local communities as they develop and implement forest management and hazardous fuel reduction

projects. In order for a community to take full advantage of this opportunity, it must prepare a Community Wildfire Protection Plan (CWPP).

composition the biological elements within the different levels of biological organization, from genes and species to communities and ecosystems.

confidence interval a range of values around the estimated mean that defines a specified probability that the value of a parameter lies within it.

contemporary vegetation management challenges are issues with controlling, restoring or improving vegetation dynamics to achieve certain resource objectives. Some examples include but are not limited to such things as controlling invasive exotic weeds, reducing fire risk in the wildland-urban interface, and finding chemical-free ways to control weeds, etc.

cohort a group of trees developing after a single disturbance, commonly consisting of trees of similar age, although it can include a considerable range of tree ages of seedling origin and trees that predate the disturbance.

connectivity the ecological conditions that exist at several spatial and temporal scales that provides landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change (36 Code of Federal Regulations 219.19). Connectivity needs vary by species.

conservation the protection, preservation, management, or restoration of natural environments, ecological communities, and species.

consumptive water use the act of removing water from an available supply and utilizing it in a manner that it is not returned to a waterbody.

coppice a forest regeneration method by which the majority of regeneration is from sprouts or root suckers. The suitable species on the HLC NF for this method is limited to aspen.

cover the elements of the environment used by an animal for hiding. Cover varies depending upon the species or the time of year and may include a variety of vegetation types as well as topography. The amount and quality of cover needed depends on the animal's size, mobility, and reluctance or willingness to venture into relatively open areas. Cover can occur as horizontal cover, which may provide security from disturbance by humans or predators, or thermal cover (often provided by vegetation canopy), which can help animals regulate body temperature during periods of extreme heat or cold.

cover type the vegetation composition of an area, described by the dominant plant species. Also see forest type.

Cretaceous is a geologic period and system from 145 ± 4 to 66 million years (Ma) ago.

critical habitat (for a threatened or endangered species) (1) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the Endangered Species Act (16 United States Code 1533), on which are found those physical or biological features (a) essential to the conservation of the species, and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the Endangered Species Act (16 USC 1533), upon a determination by the Secretary that such areas are essential for the conservation of the

species. Endangered Species Act, sec. 3 (5)(A), (16 USC 1532 (3)(5)(A)). Critical habitat is designated through rulemaking by the Secretary of the Interior or Commerce. Endangered Species Act, sec. 4 (a)(3) and (b)(2) (16 United States Code 1533 (a)(3) and (b)(2)).

crown the part of a tree or other woody plant bearing live branches and foliage.

culmination of mean annual increment of growth see mean annual increment of growth

decision document a record of decision, decision notice, or decision memo (36 Code of Federal Regulations 220.3).

dedicated skid trail a pathway used repeated, and only, to move logs or trees from the stump to a landing, where they are processed and loaded onto trucks.

deferred trail maintenance the backlog of trails in need of maintenance.

deleterious having a harmful or injurious effect.

density (stand) the number of trees growing in a given area usually expressed in terms of trees per acre.

designated area an area or feature identified and managed to maintain its unique special character or purpose; some categories of designated areas may be designated only by statute and some categories may be established administratively in the land management planning process or by other administrative processes of the federal executive branch; examples of statutorily designated areas are national heritage areas, national recreational areas, national scenic trails, wild and scenic rivers, wilderness areas, and wilderness study areas; examples of administratively designated areas are experimental forests, research natural areas, scenic byways, botanical areas, and significant caves.

designated over-the-snow route a course managed under permit or agreement or by the agency, where use is encouraged, either by on-the ground marking or by publication in brochures, recreation opportunity guides or maps (other than travel maps), or in electronic media produced or approved by the agency. The routes identified in outfitter and guide permits are designated by definition; groomed routes also are designated by definition.

desired condition (DC) a description of specific social, economic, and/or ecological characteristics of the plan area, or a portion of the plan area, toward which management of the land and resources should be directed. Also see chapter 1.

desired plant community is selected as the one species composition (of the many possible within any given ecological site or equivalent) that is most compatible with management objectives for a site. This decision depends on the relative value expected to be obtained from alternative land uses, as well as the feasibility of implementing actions required to change the present vegetation to a more desirable type. It is unlikely that the desired plant community would feature substandard levels of soil protection, biotic integrity and hydrologic function, because it is assumed that maintaining site potential should be an intrinsic goal of any management plan. Desired plant community is in essence the benchmark against which to compare existing vegetation and provides a system to evaluate the success of current practices in meeting management objectives. (Global Rangelands 2016).

diameter breast height (d.b.h.) the diameter of a tree measured 4.5 feet above the ground on the uphill side of the tree, or diameter of a log measured 4.5 feet from the large end of the log.

discretionary the exploration and development of leasable mineral resources are discretionary activities, meaning that leasing them may or may not be allowed.

disturbance an event that alters the structure, composition, or function of terrestrial or aquatic habitats; any relatively discrete event in time that disrupts ecosystem, watershed, community, or species population structure and/or function and changes resources, substrate availability, or the physical environment. Natural disturbances include, among others, drought, floods, wind, fires, wildlife grazing, and insects and pathogens; human-caused disturbances include actions such as timber harvest, livestock grazing, roads, and the introduction of exotic species.

disturbance activities are activities which result in notable vegetation removal and/or soil disturbance (road construction, timber harvest, etc.).

disturbance regime a description of the characteristic types of disturbance on a given landscape; the frequency, severity, size, and distribution of these characteristic disturbance types, and their interactions. The natural pattern of periodic disturbances, such as fire or flooding.

disturbance/displacement the repeated avoidance of humans by a species by shifting its habitat use in space or time.

driver (ecology) see ecosystem driver.

duff the partially decayed organic matter on the forest floor.

early-seral/successional stage (forest) the earliest stage in the sequence of plant communities that develop after a stand replacing disturbance, such as fire or regeneration harvest. On the forested communities of the HLC NF, this stage typically occurs in the period from 1 to 30 or 40 years after the disturbance, and is dominated by grass, forbs, shrubs, and seedling/sapling sized trees.

early successional forest patches are specifically defined for modeling purposes as areas classified into the seedling/sapling size class (less than 5” diameter) and transitional areas reforesting following disturbance (these areas have little to no tree cover but are found on forested potential vegetation types).

ecological condition the biological and physical environment that can affect the diversity of plant and animal communities, the persistence of native species, and the productive capacity of ecological systems; ecological conditions include habitat and other influences on species and the environment; examples of ecological conditions include the abundance and distribution of aquatic and terrestrial habitats, connectivity, roads and other structural developments, human uses, and invasive species.

ecological integrity the quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence. The quality of a natural unmanaged or managed ecosystem in which the natural ecological processes are sustained, with genetic, species and ecosystem diversity assured for the future.

ecological site an ecological site is a distinctive kind of land with specific soil and physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation, and in its ability to respond similarly to management actions and natural disturbances (NRCS, National Range and Pasture Handbook, December 2003).

ecological sustainability see sustainability.

ecosystem (36 Code of federal Regulations 219.19) a spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries. The term ecosystem can be used at a variety of scales; for the forest plan, the ecosystem is referred to spatially at the forestwide and geographic area scales as well as within potential vegetation types. An ecosystem is commonly described in terms of its:

- composition: The biological elements within the different levels of biological organization, from genes and individual plant and animal species to communities (such as cover types).
- structure: The organization and physical arrangement of biological elements such as, snags and down woody debris, vertical (size class and structure class) and horizontal (density) distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity.
- function: Ecological processes that sustain composition and structure, such as energy flow, nutrient cycling and retention, soil development and retention, predation and herbivory, and natural disturbances such as wind, fire, and floods.
- connectivity: See connectivity.

ecosystem driver a natural or human-induced factor that directly or indirectly causes a change in an ecosystem. Examples include climate change, fire events, invasive species and flooding.

ecosystem resilience see resilience

ecosystem service the benefit(s) people obtain from an ecosystem, including: (1) provisioning services, such as clean air and fresh water, energy, fuel, forage, fiber, and minerals; (2) regulating services, such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood control; and disease regulation; (3) supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling; and (4) cultural services, such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences and tourism opportunities.

ecosystem stressor a factor that may directly or indirectly degrade or impair ecosystem composition, structure or ecological process in a manner that may impair its ecological integrity, such as an invasive species, loss of connectivity, or the disruption of a natural disturbance regime.

ecotone a zone of transition between two distinctly different plant communities, where they meet and integrate. It may be narrow or wide; local (between a field and forest) or regional (between forest and grassland ecosystems); gradual or manifested as a sharp boundary line. This zone usually exhibits competition between organisms common to both communities. For this Plan, this term is used to describe the zone of transition between nonforested grass/shrub communities and forested communities, and may often blend with savannas. This zone shifts in location and condition based on climate influences, successional processes, and disturbance processes.

elk security The protection inherent in any situation that allows elk to remain in a defined area despite an increase in stress or disturbance associated with the hunting season or other activities (Lyon and Christensen 1992).

endangered species a species that the Secretary of the Interior or the Secretary of Commerce has determined is in danger of extinction throughout all or a significant portion of its range. Endangered species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act. Endangered species are listed at 50 Code of Federal Regulations sections 17.11, 17.12, and 224.101.

environmental document a written analysis that provides sufficient information for a responsible official to undertake an environmental review. Examples include: a categorical exclusion, an environmental assessment, and an environmental impact statement.

epidemic (outbreak) the rapid spread, growth, and development of pathogen or insect populations that affect large numbers of a host population throughout an area at the same time.

even-aged stand a stand of trees composed of a single age class (cohort). Usually trees in a single age class are within + 20 years of each other.

even-aged system a planned sequence of treatments designed to maintain and regenerate a stand with predominantly one age class. Treatments include clearcutting, seedtree, shelterwood, and coppice regeneration methods.

final regeneration harvest the final timber harvest in a sequence of harvests designed to regenerate a timber stand or release a regenerated stand. A final regeneration harvest could be a clearcut, removal of a shelterwood or seedtree system, or a selectin cut.

fine fuel the fast-drying dead or live materials, generally characterized by a comparatively high surface area-to-volume ratio, which is defined as less than 0.25 inches in diameter and having a timelag of 1 hour or less in which fuel moisture content can change by 95%. Fine fuels (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry [NWCG].

fire control see fire suppression

fire exclusion the disruption of a characteristic pattern of fire intensity and occurrence (primarily through fire suppression, but other factors such as land use changes and livestock grazing contribute as well).

fire hazard the potential fire behavior for a fuel type, regardless of the fuel type's weather-influenced fuel moisture content or its resistance to fireline construction. Fire behavior assessment is based on physical fuel characteristics, such as fuel arrangement, fuel load, condition of herbaceous vegetation, and presence of elevated fuels.

fire regime a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention but including the influence of prehistoric human burning (Agee 1993; Brown 1995; Hann and Bunnell 2001). The five natural fire regimes are classified based on the average number of years between fires combined with the severity of the fire (the amount of vegetation replacement), and its effect on the dominant overstory vegetation (Hann 2005). The five natural fire regimes on the HLC NF are as follows, with detail added to describe conditions found on the HLC NF:

Fire Regime Group	Frequency (Fire Return Interval)	Severity	Representative Vegetation Types / Habitats
I	0 to 35 years	Nonlethal, low intensity to mixed severity (less than 75 percent of the dominant overstory vegetation replaced)	Ponderosa pine, dry-site Douglas-fir *Open forest, woodland, shrub and savanna structures maintained by frequent non-lethal fire; also includes mixed severity fire that create a mosaic of different age classes, post-fire open forests. Mean fire return interval can be greater than 35 years in systems with high temporal variation. These fires result in minimal overstory mortality (<25% of dominant overstory) and small patch size (Agee 1998; Arno et al. 2000; Hessburg et al 2005). The forests that adapted to these fires on the HLC NF were often dominated by ponderosa pine or Douglas-fir; fire*

Fire Regime Group	Frequency (Fire Return Interval)	Severity	Representative Vegetation Types / Habitats
			maintained these species and promoted open, often uneven-aged, structures. Surviving fire-resistant trees reforest the gaps created by disturbance. These fires also maintained open, dry forest savanna structures and a shifting distribution of dry limber pine/juniper ecotone communities.
II	0 to 35 years	Stand-replacing (greater than 75 percent of the dominant overstory vegetation replaced)	Drier grasslands; cool-site sagebrush (such as Mountain big sagebrush) *Shrub or grasslands maintained or cycled by frequent fire; fire typically remove non-sprouting shrubs, tops of sprouting shrubs and most tree regeneration. These fires are important in vegetation communities such as big mountain sagebrush.*
III	35 to 100+ years	Nonlethal and mixed severity (less than 75 percent of the dominant overstory vegetation replaced)	Interior dry-site shrub communities (such as warm-site sagebrush - Big sage, basin big sagebrush); moist-site Douglas-fir/lodgepole pine forests *A mosaic of different ages, open forests, early to mid-seral forest structure stages, and shrub and herb dominated patches is maintained by infrequent fire events. Mixed severity fires kill a moderate amount of the overstory, burning with a mosaic of severities but replacing <75% of the overstory (Barrett et al. 2010). Highly variable patch sizes are created, with a mosaic of effects including stand replacement, low severity, and unburned areas (Agee 1998; Arno et al. 2000). This creates an irregular pattern with an abundant amount of edge. Fire tolerant species often survived many fire events, with large, old trees becoming prominent overstory components. These fires also resulted in unburned patches that could develop into climax conditions dominated by shade tolerant species.*
IV	35 to100+ years	Stand-replacing, high intensity (greater than 75 percent of the dominant overstory vegetation replaced)	Lodgepole pine *Large patches of similar age, post-fire structures and early to mid-seral forests are cycled by infrequent fire events. Stand replacing fires kill most of the trees (>75%) over a substantial area (Barrett et al. 2010) and creating an intermediate amount of edge (Agee 1998; Arno et al. 2000). Lodgepole pine regenerates large areas without a living seed source by storing serotinous cones on trees and in the soil that open under intense heat. Fire return intervals are generally long; however, shorter intervals also occur (USDA 1990; Barrett 1993) and forests may re-burn after the dead trees have fallen. Lodgepole pine produces open cones at a very young age to re-seed re-burned or understocked patches. Serotiny in fire-prone ecosystems is typically expressed from 30-60 years of age (USDA 1983) to ensure that seed is available for regeneration after the next stand-replacing event.*
V	200+ year	Stand-replacing, high intensity.	Boreal forest and high elevation conifer forest; lodgepole pine/subalpine fir; subalpine fir; whitebark pine *Variable size patches of shrub and herb dominated structures, or early to mid to late seral forest occur depending on the type of biophysical environment and are cycled by rare fire or other disturbance events. These forests often have complex structures influenced by small gap disturbances and understory regeneration. These fires result may result in the regeneration of lodgepole pine but also provide suitable sites for the establishment of whitebark pine at the highest elevations. Many sites become dominated by subalpine fir at the later stages of succession.*

fire risk the probability or chance of fire starting determined by the presence and activities of causative agents.

fire severity for this effort, it is the effect of fire within the fire perimeter in terms of replacement/removal of the upper layer vegetation and surface burning. Replacement/removal may or may not cause a lethal effect on understory vegetation or surface duff/litter and mineral soil. For example, replacement fire in grassland may remove the leaves, but leaves resprout from the undamaged basal crown, while replacement fire in most conifers cause mortality of the overstory trees.

fire suppression the work and activities connected with fire extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

fire-adapted species a plant type that has evolutionary adaptations to survive and thrive in an ecosystem where fire is a primary driver, including tree species that are termed fire-tolerant as well as trees and other plant species that have a myriad of other types of adaptations. Some examples of adaptations are the serotinous cones of lodgepole pine (which open only when heated in a fire); fast early tree growth for rapid site domination; rhizomatous (below ground) root systems or root crowns; seeds with hard, fire resistant seed-coats; or very lightweight, wind-dispersed seed (also see fire-tolerant species).

fire-intolerant tree species a tree type that is susceptible to severe damage or mortality in a fire event. Characteristics typically include thin bark at maturity, crowns that retain lower branches (close to the ground), less protected buds and needles. For example, subalpine fir, grand fir and spruce are fire-intolerant species in the HLC NF.

fire-tolerant tree species a tree type resistant to severe damage or mortality in a fire event. Characteristics include thick bark at maturity, readily self-pruning (lower branches are shed as the tree grows), and protected buds. Examples of fire-tolerant species on the HLC NF are western larch, ponderosa pine and, to a lesser extent, Douglas-fir.

fish passage a clear access for migrating fish through a potential barrier.

flame length the distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity [NWCG].

focal species a small subset of species whose status permits inference to the integrity of the larger ecological system to which it belongs and provides meaningful information regarding the effectiveness of the plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area. Focal species would be commonly selected on the basis of their functional role in ecosystems (36 Code of Federal Regulations 219.19).

food-conditioned (bear) a bear that associates humans and areas of human activity (e.g., campgrounds, cabins, dwellings, etc.) with food, usually as a result of repeatedly obtaining food rewards (e.g., garbage, camp food, pet or livestock food, bird seed, etc.) in such areas.

forage the browse and nonwoody plants available to livestock or wildlife for feed.

forage allocations for ecological needs at the allotment management planning level a determination of forage production for the dominant ecological sites (or their equivalent) within the grazing allotment is determined. Forage allocations permitted for livestock grazing are made after analyzing the effects to other resources. Examples of resource areas taken into consideration prior to determining forage availability for livestock grazing include soil health, native plant community viability and resilience, hydrologic function, aquatic habitat quality, and the forage and cover needs of wildlife species.

forb a herbaceous (herb-like) plant other than grass or grass-like plants.

forest connectivity see 'connectivity' above; an area providing those functions for wildlife species that prefer to remain within or close to forested cover.

forest dominance type a classification that reflects the most common tree species within a forest stand. The dominant species comprises at least 40 percent of the stocking, as measured by canopy cover, basal area, or trees per acre, depending on available information and stand characteristics.

forest floor All organic matter generated by forest vegetation, including litter and unincorporated humus, on the mineral soil surface.

forest health the perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance. A useful way to communicate about the current condition of the forest, especially with regard to the ability of the ecosystem to respond to disturbances. Note: perception and interpretation of forest health are influenced by individual and cultural viewpoints, land management objectives, spatial and temporal scales, the relative health of the stands that comprise the forest, and the appearance of the forest at a point in time.

forest land an area at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for nonforest uses. Lands developed for nonforest use include areas for crops, improved pasture, residential or administrative sites, improved roads of any width and adjoining road clearing, and power line clearings of any width.

forest management the practical application of biological, physical, quantitative, managerial, economic, social, and policy principles to the regeneration, management, utilization, and conservation of forests to meet specified goals and objectives while maintaining the productivity of the forest. Note: forest management includes management for aesthetics, fish, recreation, urban values, water, wilderness, wildlife, wood products, and other forest resource values. Forest management varies in intensity from leaving the forest alone, to a highly intensive regime composed of periodic silvicultural treatments.

forest plan a document that guides sustainable, integrated resource management of the resources within a plan area and within the context of the broader landscape, giving due consideration to the relative values of the various resources in particular areas (36 Code of Federal Regulations 219.1(b)). Consistent with the Multiple-Use Sustained-Yield Act of 1960 (16 United States Code 528–531), the FS manages NFS lands to sustain the multiple use of its renewable resources in perpetuity while maintaining the long-term health and productivity of the land. Resources are managed through a combination of approaches and concepts for the benefit of human communities and natural resources.

forest structure a complex three-dimensional construct consisting of the various horizontal and vertical physical elements of the forest, including tree diameters, tree heights, tree ages, stand density, canopy layers, quantity/quality of deadwood, herbaceous species, and the clumpiness of the stand. There is no one measure to quantify or describe structure. Often individual forest attributes are described and integrated to evaluate forest structure, such as tree sizes or ages or number of canopy layers.

forest system road see NFS road.

forest type a category of forest usually defined by its vegetation, particularly its dominant vegetation as based on percentage cover of trees (for example, subalpine fir/spruce; lodgepole pine).

fuel management an act or practice of controlling flammability and reducing resistance to control of wildand fuels through mechanical, chemical, biological or manual means, or by fire, in support of land management objectives. [NWCG]

fuel model a set of surface plant material characteristics (for example, load and surface-area-to-volume-ratio by size class, heat content, and depth) organized for input to a fire model. Standard fuel models (such as Anderson 1982) have been stylized to represent specific fuel conditions.

fuel treatment the manipulation or removal of dead or live plant materials to reduce the likelihood of ignition and/or lessen potential damage and resistance to fire control (example treatments include, lopping, chipping, crushing, piling and burning). [NWCG]

fuelwood a term for wood that is used for conversion to a form of energy (for example, firewood, biomass).

function ecological processes that sustain composition and structure, such as energy flow, nutrient cycling and retention, soil development and retention, predation and herbivory, and natural disturbances such as wind, fire, and floods.

geographic area (GA) a spatially contiguous land area identified within the plan area. A geographic area may overlap with a management area (36 Code of Federal Regulations 219.19).

geographic information system (GIS) a computer process that links database software to graphics (spatially explicit) software and provides database and analytic capabilities.

goals (GO) broad statements of intent, other than desired conditions, usually related to process or interaction with the public. Also see chapter 1.

gradient (stream) the slope of a streambed.

graminoids grasses.

grazing allotment a designated area of land that is available for livestock grazing and is represented on a map. A grazing allotment can include NFS and non-NFS lands. Permits are issued for the use of allotments or portions of allotments. Allotments may be FS Manual 2205):

- active: Livestock grazing allotments, including pack and saddle stock allotments.
- closed: Areas having suitable livestock range that have been closed to livestock grazing by administrative decision or action.
- combined: An allotment that has been combined into another allotment, and therefore, no longer exists as an independent allotment.
- vacant: An allotment that does not have a current grazing permit issued.

grazing permit in nonuse status a term that applies to circumstances where a grazing permit holder either does not place any livestock, or at numbers less than 90% of permitted, on an allotment due to personal convenience, resource protection, or range research reasons (FSH 2209.13). Approval for grazing permit non-use is granted by a Forest Service authorized officer prior to livestock turnout for the specific grazing year.

Grizzly Bear Conservation Strategy (GBCS) a document published by the U.S. Fish and Wildlife Service that describes the regulatory framework for management of the Northern Continental Dive

Ecosystem grizzly bear population and its habitat upon recovery and subsequent removal from the Federal list of Threatened and Endangered Species.

ground cover is the material on the soil surface that impedes raindrop impact and overland flow of water. Ground cover consists of all living and dead herbaceous and woody material in contact with the ground and all rocks greater than 0.75 inches in diameter.

ground fire a term used to describe organic material, such as duff, organic soils, roots, and rotten buried logs, burning beneath the surface. [NWCG]

ground-based logging system a log skidding method using tracked or wheeled tractors. These tractors or "skidders" typically operate on gentle slopes (for example, on slopes less than 40%). Steeper slopes may require cable logging systems.

groundwater-dependent ecosystem a community of plants, animals, and other organisms whose extent and life processes depend on groundwater. Examples include many wetlands, groundwater-fed lakes and streams, cave and karst systems, aquifer systems, springs, and seeps.

group selection method a cutting method to develop and maintain uneven-aged stands by the removal of small groups of trees (generally up to 0.5 acre in size) at periodic intervals to meet a predetermined goal of size distribution and species composition in remaining stands.

group use an activity conducted on NFS lands that involves a group of 75 or more people, either as participants or spectators (36 Code of Federal Regulations 251.51).

guide to provide services or assistance (such as supervision, protection, education, training, packing, touring, subsistence, transporting people, or interpretation) for pecuniary remuneration or other gain to individuals or groups on NFS lands (36 Code of Federal Regulations 251.51).

guideline (GDL) a constraint on project and activity decision-making that allows for departure from its terms, so long as the purpose of the guideline is met. Also see chapter 1.

habitat type an aggregation of plant communities of similar biophysical characteristics, and similar function and response to disturbances. A habitat type will produce similar plant communities at climax. On the HLC NF, habitat types are based upon Pfister et al. 1977. Also see potential vegetation type.

habituated (bear) a bear that does not display avoidance behavior near humans or in human use areas (e.g., campgrounds, lodges, town sites, cabin or dwelling yards, within 100m of open roads, etc.), as a result of repeated exposure to those circumstances.

hazard tree a tree that has the potential to cause property damage, personal injury or fatality in the event of a failure, where failure is the mechanical breakage of a tree or tree part. Failures often result from the interaction of defects, weather factors, ice or snow loading or exposure to wind. Tree hazards may include dead or dying trees, dead parts of live trees, or unstable live trees (due to structural defects or other factors) that are within striking distance of people or property (a target). Defects are flaws in a tree that reduce its structural strength. Trees may have single or multiple defects, which may or may not be detectable. Failures result in accidents only if they strike a target.

Healthy Forests Restoration Act the public law (108-148), passed in December 2003, which provides statutory processes for hazardous fuel reduction projects on certain types of at-risk NFS and Bureau of Land Management managed public lands. The Healthy Forests Restoration Act also provides other

authorities and direction to help reduce hazardous fuel and restore healthy forest and rangeland conditions on lands of all ownerships. [NRLMD]

heterogeneity exhibiting dissimilarity among members of a group (Helms 1998).

highway a term that includes all roads that are part of the National Highway System. (23 Code of Federal Regulations 470.107(b))

high use areas areas that receive high levels of visitor use such as trailheads, developed campgrounds, etc.

historic climax the plant community that existed at the time of European immigration and settlement in North America. It is the plant community that was best adapted to the unique combination of environmental factors associated with the site. The historic climax plant community was in dynamic equilibrium with its environment. It is the plant community that was able to avoid displacement by the suite of disturbances and disturbance patterns (magnitude and frequency) that naturally occurred within the area occupied by the site.

historical range of variation the variation in ecological conditions resulting from disturbance regimes and other natural influences under which the ecosystem and forests evolved. Typically refers to the period prior to the dramatic changes in human land uses and patterns beginning with the influx of European-Americans about the mid-1800s. Historical range of variation is considered valuable for providing a context or frame of reference to evaluate current ecosystem conditions and understanding what an ecologically healthy and sustainable condition might look like. Also see natural range of variation.

home range an area, from which intruders may or may not be excluded, to which an individual animal restricts most of its usual activities.

hydrologic unit code (HUC) The United States is divided and sub-divided into successively smaller hydrologic units (watersheds) which are classified into six levels: regions (HUC 1), sub-regions (HUC 2), basin (HUC 3), subbasin (HUC 4), watershed (HUC 5), subwatersheds (HUC 6). The hydrologic units are arranged or nested within each other, from the largest geographic area (regions) to the smallest geographic area (cataloging units). Each hydrologic unit is identified by a unique hydrologic unit code consisting of two to twelve digits based on the levels of classification in the hydrologic unit system.

inherent capability of the plan area the ecological capacity or ecological potential of an area characterized by the interrelationship of its physical elements, its climatic regime, and natural disturbances.

integrated resource management a means to realize many benefits from a forest or other natural area and assure the renewable benefits are there for future generations. [NWCG]

integrity (ecology) see ecological integrity

interagency consultation a process required by Section 7 of the Endangered Species Act whereby federal agencies proposing activities in a listed species habitat confer with the USFWS about the impacts of the activity on the species.

intermediate harvest a removal of trees from a stand between the time of its formation and a regeneration harvest. Most commonly applied intermediate cuttings are release, thinning, improvement, and salvage.

intermittent stream a stream that flows only at certain times of the year when it receives water, usually from springs or a surface source such as melting snow.

invasive plant management activities activities designed to locate, monitor, prevent and reduce invasive species infestations. These include prevention, survey, inventory, treatment, and monitoring activities.

invasive species an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. A species that causes, or is likely to cause, harm and that is exotic to the ecosystem it has infested. Invasive species infest both aquatic and terrestrial areas and can be identified within any of the following four taxonomic categories: plants, vertebrates, invertebrates, and pathogens (Executive Order 13112).

key ecosystem characteristic the dominant ecological characteristic(s) that describes the composition, structure, function and connectivity of terrestrial, aquatic and riparian ecosystems that are relevant to addressing important concerns about a land management plan. Key ecosystem characteristics are important to establishing or evaluating plan components that would support ecological conditions to maintain or restore the ecological integrity of ecosystems in the plan area.

laccolith is a sheet intrusion (or concordant pluton) that has been injected between two layers if sedimentary rocks. The pressure of the magma is high enough that the overlying strata's are forced upwards forming a dome shape rock formation.

lacustrine of, relating to, or associated with lakes

ladder fuel a term to describe plant materials that provide vertical continuity between forest strata, thereby allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease.

land management plan see forest plan

landscape a defined area irrespective of ownership or other artificial boundaries, such as a spatial mosaic of terrestrial and aquatic ecosystems, landforms, and plant communities, repeated in similar form throughout such a defined area (36 Code of Federal Regulations 219.19).

landtype a unit shown on an inventory map with relatively uniform potential for a defined set of land uses. Properties of soils landform, natural vegetation, and bedrock are commonly components of landtype delineation used to evaluate potentials and limitations for land use.

large/very large live tree concentrations are defined using the following minimum criteria:

- warm dry potential vegetation type: Large tree concentrations are areas with at least 5 trees per acre of trees greater than or equal to 15" diameter. Very large tree concentrations are areas with at least 4 trees per acre greater than or equal to 20" diameter.
- cool moist potential vegetation type: Large tree concentrations are areas with at least 10 trees per acre of trees greater than or equal to 15" diameter. Very large tree concentrations are areas with at least 10 trees per acre greater than or equal to 20" diameter.
- cold potential vegetation type: Large tree concentrations are areas with at least 8 trees per acre of trees greater than or equal to 15" diameter. Very large tree concentrations are areas with at least 8 trees per acre greater than or equal to 20" diameter

late-seral/successional stage (forest) a late stage in the sequence of plant communities that develops after a disturbance, such as fire or harvest. On the forested communities of the HLC NF, this stage may begin to develop 140 years or more after the disturbance. Forest structures can be very diverse, with wide

range in densities, number of canopy layers and trees sizes. Usually larger trees are dominant (greater than16 inches diameter breast height).

Lidar is a detection system that works on the principle of radar but uses a light from a laser.

linkage (also linkage habitat, linkage area, or linkage zone) an area that will support a low density population of a species during certain parts of the year, and that facilitates demographic or genetic connectivity between geographically separate patches of habitat suitable for that species. Linkage areas facilitate movements of an animal (for example, dispersal, breeding season movements, exploratory movements) beyond its home range. Linkage areas may include sizeable areas of nonhabitat and areas influenced by human actions.

livestock a type of domestic animal raised for commercial production purposes (for example, cattle). Small livestock includes animals such as sheep, goats, and llamas.

livestock movement guides defined utilization limits for key species developed at the allotment management plan level that when achieved would trigger the need for livestock to be moved to the next scheduled pasture/area or off of the allotment depending on the authorized management system in place on any respective allotment.

losing stream is a stream or river that loses its water as it flows downstream. Water infiltrates into the ground recharging the local groundwater because the groundwater is below the bottom of the stream channel.

lynx habitat an area within a boreal forest with gentle rolling topography, dense horizontal cover, deep snow, and moderate to high snowshoe hare densities (more than 1 hare/2 ha (0.4 hares/2 ac)). In the western United States, forest cover types dominated by Engelmann spruce, subalpine fir and lodgepole pine provide habitat for lynx. [LCAS]

maintain to keep in existence or continuance of the desired ecological condition in terms of its desired composition, structure, and processes. Depending upon the circumstance, ecological conditions may be maintained by active or passive management or both.

management area a land area identified within the plan area that has the same set of applicable plan components. A management area does not have to be spatially contiguous (36 Code of Federal Regulations 219.19).

management system (timber) an administrative method that includes even-aged stand and uneven-aged stand protocols.

mature multi-story structural stage (forest) a phase characterized by understory reinitiation, resulting in several tree age classes and vegetation layers. Fallen trees may be present, creating gaps in the overstory canopy. In lynx habitat, these stands typically have high horizontal cover from young understory trees and lower limbs of mature trees that reach the ground or snow level. [LCAS]

mature tree a tree which has achieved its maximum or near-maximum mean annual rate of growth in height or diameter.

MBF/MMBF (thousand board feet and million board feet, respectively) a specialized unit of measure for the volume of lumber in the United States and Canada. One board foot is the volume of a 1-foot length of a board 1 foot wide and 1 inch thick.

mean annual increment of growth the total increment of increase in volume of a stand (standing crop plus thinning removals) up to a given age divided by that age. Culmination of mean annual increment of growth is the age in the growth cycle of an even-aged stand at which the average annual rate of increase of volume is at a maximum. In land management plans, mean annual increment is expressed in cubic measure and is based on the expected growth of stands, according to intensities and utilization guidelines in the plan.

mechanized travel/mechanical transport a contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and that is powered by a living or nonliving power source. This includes, but is not limited to, sailboats, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snowshoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts (36 Code of Federal Regulations 2320.5(3)).

mesic a type of habitat that is moderately moist.

mid-seral/successional stage (forest) a mid-stage in the sequence of plant communities that develop after a disturbance, such as fire or harvest. On the forested communities of the HLC NF, stands may be considered in this stage from about 40 to 140 years after the disturbance. Stand structure, such as density and number of canopy layers, can vary widely. Dominant tree sizes are typically from 5 to 15 inches diameter breast height.

mine reclamation the process of restoring land that has been mined to a natural or economically usable state. Although the process of mine reclamation occurs once mining is completed, the preparation and planning of mine reclamation activities occur prior to a mine being permitted or started.

minerals the FS defines three types of mineral (and energy) resources:

- locatable minerals: Commodities such as gold, silver, copper, zinc, nickel, lead, platinum, etc. and some nonmetallic minerals such as asbestos, gypsum, and gemstones.
- salable minerals: Common varieties of sand, stone, gravel, cinders, clay, pumice and pumicite.
- leasable minerals: Commodities such as oil, gas, coal, geothermal, potassium, sodium phosphates, oil shale, sulfur, and solid leasable minerals on acquired lands.

mitigate to avoid, minimize, rectify, reduce, or compensate the adverse environmental impacts associated with an action.

mixed-severity fire/mixed-severity fire regime a combination of nonlethal, low-intensity to stand-replacing fire effects within the perimeter of a single fire, or across consecutive events. Mixed-severity fire regimes give rise to unique patch dynamics and ecosystem responses.

modified thinning technique a precommercial thin prescription for a stand dominated by seedling or sapling size trees specifying use of techniques designed to develop multiple tree canopy layers over time, enhancing long-term species and structural diversity within forest stands, and contributing to forest conditions more resilient to future disturbance and climate change (also see appendix B, potential management strategies, Canada lynx habitat section).

monitoring a systematic process of collecting information to evaluate effects of actions or changes in conditions or relationships.

motorized equipment a machine that uses a motor, engine, or other nonliving power sources. This includes, but is not limited to, such machines as chain saws, aircraft, snowmobiles, generators, motorboats, and motor vehicles. It does not include small battery or gas powered hand carried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment.

motorized route a NFS road or NFS trail that is designated for motorized use on a motor vehicle use map pursuant to 36 Code of Federal Regulations 212.51

motorized use the designation of roads, trails, and areas that are open to motor vehicle use as specified in Federal Register / Volume 70, Number 216 / Wednesday, November 9, 2005 /36 Code of federal Regulations Parts 212, 251, 261, Travel Management; Designated Routes and Areas for Motor Vehicle Use; Final Rule.

multiple use is defined by the Multiple-Use Sustained-Yield Act of 1960 (16 United States Code 528–531) as "the management of the various renewable surface resources of the NFS so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output." Additionally, the first paragraph of the MUSY Act states, "Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that, it is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes" (emphasis added).

National Forest System the National Forest lands reserved or withdrawn from the public domain of the United States, all National Forest lands acquired through purchase, exchange, donation, or other means, the National Grasslands and land utilization projects administered under title III of the Bankhead-Jones Farm Tennant Act (50 Stat. 525, 7 United States Code 1010-1012), and other lands, waters or interests therein which are administered by the FS or are designated for administration through the FS as a part of the system.

native knowledge a way of knowing or understanding the world, including traditional ecological and social knowledge of the environment derived from multiple generations of indigenous peoples' interactions, observations, and experiences with their ecological systems. Native knowledge is place-based and culture-based knowledge in which people learn to live in and adapt to their own environment through interactions, observations, and experiences with their ecological system. This knowledge is generally not solely gained, developed by, or retained by individuals, but is rather accumulated over successive generations and is expressed through oral traditions, ceremonies, stories, dances, songs, art, and other means within a cultural context.

native species an organism that was historically or is present in a particular ecosystem as a result of natural migratory or evolutionary processes; and not as a result of an accidental or deliberate introduction into that ecosystem. An organism's presence and evolution (adaptation) in an area are determined by climate, soil, and other biotic and abiotic factors.

natural range of variation (NRV) the variation of ecological characteristics and processes over scales of time and space that are appropriate for a given management application. Also see historical range of variation. The natural range of variation (or historic range of variation) is a tool for assessing the

ecological integrity and does not necessarily constitute a management target or desired condition. The natural range of variation can help identify key structural, functional, compositional, and connectivity characteristics, for which plan components may be important for either maintenance or restoration of such ecological conditions.

natural regeneration a renewal of a tree crop by natural seeding, sprouting, suckering, or layering.

nonattainment area an area within a State that exceeds the national ambient air quality standards.

nonconsumptive water use the act of removing water from an available supply and utilizing it in a manner that it returns to a waterbody.

nondiscretionary exploration and development of locatable mineral resources are nondiscretionary activities, meaning that the Forest Service cannot prohibit reasonably necessary activities required or the exploration, prospecting, or development of valuable mineral deposits.

nonpoint source pollution a discharge from a diffuse source, such as polluted runoff from an agricultural area or precipitation, to a water body.

Northern Continental Divide Ecosystem a region identified in the Grizzly Bear Conservation Strategy encompassing about 110,636 sq. km. of western and central Montana, that is one of five areas in the lower 48 states where grizzly bear populations occur.

noxious weed an exotic plant species established, or that may be introduced in the area, which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses.

objective (OBJ) a concise, measurable, and time-specific statement of a desired rate of progress toward a desired condition or conditions. Also see chapter 1.

occupied lynx habitat mapped lynx habitat is considered occupied by lynx when [2006 Amendment to the Canada Lynx Conservation Assessment]:

1. There are at least 2 verified lynx observations or records since 1999 on the national forest unless they are verified to be transient individuals; or
2. There is evidence of lynx reproduction on the national forest

off-highway vehicle a motor vehicle designed for, or capable of, cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain (36 Code of Federal Regulations 212.1).

old growth forest an ecosystem that is distinguished by old trees and related structural attributes. This term is deliberately defined generically, as the use of the term old growth and definitions for old growth vary substantially by ecological regions, forest types, local conditions, literature source, and a host of other factors. In the context of the HLC NF ecosystem the definitions for old growth are those provided within the document titled “Old Growth Forest Types of the Northern Region (Green et al. 1992, and errata 12/11).

old-growth associated species the group of wildlife species that is associated with old-growth forest plant communities on the HLC NF.

old-growth habitat a community of forest vegetation characterized by a diverse stand structure and composition along with a significant showing of decadence. The stand structure will typically have multi-

storied crown heights and variable crown densities. There is a variety of tree sizes and ages ranging from small groups of seedlings and saplings to trees of large diameters exhibiting a wide range of defect and breakage both live and dead, standing and down. The time it takes for a forest stand to develop into an old-growth habitat condition depends on many local variables such as forest type, habitat type, and climate. Natural chance events involving forces of nature such as weather, insect, disease, fire, and the actions of man also affects the rate of development of old-growth stand conditions. Old-growth habitat may or may not meet the definition for old growth forest (Green et al 1992).

opening (as pertaining to maximum opening size standard for timber harvest) a forest patch in a seedling/sapling size class (average stand diameter breast height is less than five inches) created as a result of one even-aged harvest operation (clearcut, seedtree or shelterwood seed cutting). Legacy or reserve trees left to meet other desired conditions are not counted in the calculation of size class for determining the seedling/sapling classification. Adjacent seedling/sapling stands created as a result of an earlier harvest operation are not considered part of an opening.

outfitting to rent on, or deliver to, NFS lands for pecuniary remuneration or other gain any saddle or pack animal, vehicle, boat, camping gear, or similar supplies or equipment (36 Code of Federal Regulations 251.51).

over snow motorized use an activity involving a motor vehicle that is designed for use over snow and that runs on a track or tracks and/or a ski or skis, while in use over snow (36 Code of Federal Regulations 212.1, Definitions).

over snow standard season the time period for over snow motorized use. Generally, the season is defined as December 1 to March 31 of each year; however exceptions apply in specific areas and are noted at the applicable locations as well as in Over Snow Vehicle Use Maps for the HLC NF.

overstory the portion of the trees that form the uppermost canopy layer in a forest of more than one story.

passive crown fire a type of fire in which individual or small groups of trees torch out, but solid flaming in the canopy cannot be maintained except for short periods. Passive crown fire encompasses a wide range of crown fire behavior from the occasional torching of an isolated tree to a nearly active crown fire. Also called torching and candling.

patch an area distinguished from its surroundings by environmental discontinuities, such as a small area of early seral/successional forest (seedling/sapling size class) surrounded by mid-seral and late-seral/successional forest (small to large tree size classes).

perennial a stream that flows continuously throughout most years and whose upper surface generally stands lower than the water table in the region adjoining the stream.

permit a special use authorization which provides permission, without conveying an interest in land, to occupy and use NFS land or facilities for specified purposes, and which is both revocable and terminable (36 Code of Federal Regulations 251.51).

permit modification the revision of one or more grazing permit terms and conditions made in accordance with 36 Code of Federal Regulations 222.4(a)(7) or (a)(8) (or applicable Code of Federal Regulations as revised).

piscicide chemical substance which is poisonous to fish.

plan a document, or set of documents, that provides management direction for an administrative unit of the NFS developed under the requirements of the 2012 Planning Rule or a prior planning rule. Also see forest plan.

plan area the NFS lands covered by a forest plan.

planned fire Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and where applicable, National Environmental Policy Act requirements must be met, prior to ignition.

Pleistocene is the geological epoch which lasted from about 2,588,000 to 11,700 years ago, spanning the world's recent period of repeated glaciations.

palustrine includes any inland wetland which lacks flowing water. Wetlands within this category include inland marshes and swamps, as well as bogs, fens and floodplains.

point source pollution a discharge from a known pollutant source , such as a sewage treatment plant, to a water body from a single location.

pole a tree at least 5 inches diameter breast height and smaller than 8 inches diameter at breast height.

potential vegetation type/potential vegetation group an assemblage of habitat types on the basis of similar biophysical environments, such as climate, slope and soil characteristics. This biophysical environment influences the vegetation characteristics and ecosystem processes that occur. The vegetation communities and conditions that would develop over time given no major natural or human disturbances (the climax plant community) would be similar within a particular potential vegetation type classification.

Precambrian is the largest span of time in Earth's history before the current Phanerozoic Eon. It spans from the formation of Earth about 4.6 billion years ago (Ga) to the beginning of the Cambrian Period, about 541 million years ago (Ma), when hard-shelled creatures first appeared in abundance.

precommercial thinning the selective felling, deadening, or removal of trees in a young stand dominated by trees less than 5 inches diameter breast height. Primary purposes for thinning include to accelerate diameter increment on the remaining stems, to maintain a specific stocking or stand density range, to develop desired tree species composition, and/or to improve the vigor and quality of the trees that remain.

prescribed burning or prescribed fire a fire ignited via management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and National Environmental Policy Act requirements (where applicable) must be met, prior to ignition. [NWCG]

primary constituent element specific biological or physical features that provide for a species' life history processes and are essential to the conservation of the species (Canada lynx).

productivity the capacity of NFS lands and their ecological systems to provide the various renewable resources (such as timber) in certain amounts in perpetuity. In land management, productivity is an ecological term, not an economic term.

projected timber sale quantity the estimated quantity of timber meeting applicable utilization standards that is expected to be sold during the plan period. As a subset of the projected wood sale quantity (PWSQ), the projected timber sale quantity includes volume from timber harvest for any purpose from lands in the plan area based on expected harvests that would be consistent with the plan components. The

PTSQ is also based on the planning unit's fiscal capability and organizational capacity. Projected timber sale quantity is not a target nor a limitation on harvest, and is not an objective unless the responsible official chooses to make it an objective in the plan.

projected wood sale quantity the estimated quantity of timber and other wood products that is expected to be sold from the plan area for the plan period. The projected wood sale quantity consists of the projected timber sale quantity as well as other woody material such as fuelwood, firewood, or biomass that is also expected to be available for sale. The projected wood sale quantity includes volume from timber harvest for any purpose based on expected harvests that would be consistent with the plan components. The projected wood sale quantity is also based on the planning unit's fiscal capability and organizational capacity. Projected wood sale quantity is not a target nor a limitation on harvest, and is not an objective unless the responsible official chooses to make it an objective in the plan.

project an organized effort to achieve an outcome on NFS lands identified by location, tasks, outputs, effects, times, and responsibilities for execution (36 Code of Federal Regulations 219.19).

proposed action a project, activity, or action that a federal agency aims to implement or undertake, and which is the subject of an environmental analysis. Proposed action is a specific term defined under the National Environmental Policy Act.

proposed species a type of animal or plant that is proposed by the USFWS, or the National Marine Fisheries Service, through the Federal Register to be listed for protection under Section 4 of the Endangered Species Act.

public involvement a process designed to broaden the information base upon which agency decisions are made. The process involves informing the public about FS activities, plans, and decisions, and participation in the planning processes which lead to final decision making.

rangelands are land on which the indigenous vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem. If plants are introduced, they are managed similarly. Rangelands include natural grasslands, savannas, shrublands, many deserts, tundra, alpine communities, marshes, and wet meadows (Society for Range Management 1999). Also included in this definition are oak and pinyon-juniper woodlands.

rangeland health the degree to which the integrity of the soil and ecological processes are sustained.

range improvements developments and/or activities (treatments) intended to improve rangeland and watershed conditions, enhance wildlife habitat, enhance or improve livestock grazing management or serve similar purposes. There are two kinds of range improvements: nonstructural and structural. Seedings or prescribed burns are examples of nonstructural range improvements. Fences or facilities such as wells or water pipelines are examples of structural improvements.

reach a length of stream channel, lake, or inlet exhibiting, on average, uniform hydraulic properties and morphology.

rearing habitat a stable and protected micro-environment for a species to birth and rear their young. For example, for juvenile westslope cutthroat trout, rearing habitat is primarily the pool environment found in streams.

reasonable assurance a judgment made by the Responsible Official based on the best available scientific information and local professional experience that practices based on existing technology and knowledge

are likely to deliver the intended results. Reasonable assurance applies to average and foreseeable conditions for the area and does not constitute a guarantee to achieve the intended results.

recently burned forest a forest area that has burned (via natural or planned ignition) in the last 10 years. These areas contain specific vegetation characteristics including recently burned snags.

recovery the improvement in the status of a listed species to the point at which listing as federally endangered or threatened is no longer appropriate (36 Code of Federal Regulations 219.19). This definition is for the purposes of the land management planning regulation at 36 Code of Federal Regulations part 219 and Land Management Planning Handbook 1909.12, and with respect to threatened or endangered species.

recovery plan a document that details actions or conditions necessary to promote improvement in the status of a species listed under the Endangered Species Act, to the point at which listing is no longer appropriate.

recreation the set of recreation settings and opportunities on the NFS that is ecologically, economically, and socially sustainable for present and future generations. Also see sustainable recreation.

recreation development scale a relative scale of development that is used in Forest Service recreation management and planning to describe the level of development associated with the diverse recreation opportunity spectrum settings within the forest.

> **recreation development scale 1** recreation sites with minimum site modification. Rustic or rudimentary improvements designed for protection of the site rather than comfort of the users. Use of synthetic materials excluded. Minimum controls are subtle. No obvious regimentation. Spacing informal and extended to minimize contacts between users. Motorized access not provided or permitted. Development scale 1 recreation sites are most associated with Primitive ROS settings.
>
> **recreation development scale 2** recreation sites with little site modification. Rustic or rudimentary improvements designed primarily for protection of the site rather than the comfort of the users. Use of synthetic materials avoided. Minimum controls are subtle. Little obvious regimentation. Spacing informal and extended to minimize contacts between users. Motorized access provided or permitted. Primary access over primitive roads. Interpretive services informal. Development scale 2 recreation sites are most associated with Semi-primitive ROS settings (both non-motorized and motorized).
>
> **recreation development scale 3** recreation sites with moderate modification. Facilities about equal for protection of natural site and comfort of users. Contemporary/rustic design of improvements is usually based on use of native materials. Inconspicuous vehicular traffic controls usually provided. Roads may be hard surfaced and trails formalized. Development density about three family units per acre. Primary access may be over high standard roads. Interpretive services informal, but generally direct. Development scale 3 recreation sites are most associated with Roaded Natural ROS settings.
>
> **recreation development scale 4** recreation site that are heavily modified. Some facilities designed strictly for comfort and convenience of users. Luxury facilities not provided. Facility design may incorporate synthetic materials. Extensive use of artificial surfacing of roads and trails. Vehicular traffic control usually obvious. Primary access usually over paved roads. Development density about three to five family units per acre. Plant materials usually native.

Interpretive services often formal or structured. Development scale 4 recreation sites are most associated with Rural ROS settings.

recreation development scale 5 recreation sites with a high degree of site modification. Facilities mostly designed for comfort and convenience of users and usually include flush toilets; may include showers, bathhouses, laundry facilities, and electrical hookups. Synthetic materials commonly used. Formal walks or surfaced trails. Regimentation of users is obvious. Access usually by high-speed highways. Development density about five or more family units per acre. Plant materials may be foreign to the environment. Formal interpretive services usually available. Designs formalized and architecture may be contemporary. Mowed lawns and clipped shrubs not unusual. Development scale 5 recreation sites are most associated with Urban ROS settings.

recreation event a recreational activity conducted on NFS lands for which an entry or participation fee is charged, such as animal, vehicle, or boat races; dog trials; fishing contests; rodeos; adventure games; and fairs.

recreation opportunity spectrum the opportunity to participate in a specific recreation activity in a particular recreation setting to enjoy desired recreation experiences and other benefits that accrue. Recreation opportunities include nonmotorized, motorized, developed, and dispersed recreation on land, water, and in the air. The six classes are the following:

- **primitive** large, remote, wild, and predominately unmodified landscapes. There is no motorized activity and little probability of seeing other people. Primitive ROS settings are managed for quiet solitude away from roads, people, and development. There are few, if any facilities or developments. Most of the primitive recreation opportunity spectrum settings coincide with designated wilderness boundaries.
- **semi-primitive nonmotorized** large, semi-remote, areas of the forest that provide for backcountry nonmotorized uses. Mountain bikes and other mechanized equipment are often present. Rustic facilities are present for the primary purpose of protecting the natural resources of the area. These settings are not as vast or remote as the primitive ROS settings, but offer opportunities for exploration, challenge, and self-reliance.
- **semi-primitive motorized** large, semi-remote areas of the forests that provide for motorized backcountry motorized on designated routes or in designated areas. Routes are designed for off highway vehicles and other high clearance vehicles. This setting offers visitors motorized opportunities for exploration, challenge, and self-reliance. Mountain bikes and other mechanized equipment are also sometimes present. Rustic facilities are present for the primary purpose of protecting the natural resources of the area or providing portals to adjacent areas of primitive, or semi-primitive, nonmotorized areas.
- **roaded natural** the roaded natural setting is managed as natural appearing with nodes and corridors of development that support higher concentrations of use, user comfort, and social interaction. The road system is well defined and can typically accommodate sedan travel. System roads also provide easy access to adjacent in semi-primitive motorize, semi-primitive nonmotorized and primitive areas.
- **rural** the rural settings represent the developed recreation sites and modified natural settings with higher concentrations of use and increased opportunities for group recreation activities and social interactions. Facilities are designed primarily for user comfort and convenience. The road system is well defined, often paved, and can easily accommodate all forms of transportation. Rural settings often include a combination of private lands intermixed with FS lands.

- **urban** the urban setting is characterized by a substantially developed environment although the background may have natural appearing elements. Highly developed ski areas, visitor centers, interpretive centers, and resorts are examples of an urban setting on National FS lands. Urban areas offer visitor comfort and convenience and modern building materials, such as concrete and asphalt, are a common occurrence.

recreation setting the social, managerial, and physical attributes of a place that, when combined, provide a distinct set of recreation opportunities. The FS uses the recreation opportunity spectrum to define recreation settings and categorize them into six distinct classes: primitive, semi-primitive nonmotorized, semi-primitive motorized, roaded natural, rural, and urban. Also see recreation opportunity.

reforestation the renewal of forest cover by planting, seeding, and natural means (such as seed from existing trees on the site).

refugia location and habitats that support populations of organisms that are limited to small fragments of their geographic range

regeneration the renewal of a forest, whether by natural or artificial means. This term may also refer to a tree crop itself.

regeneration harvest any removal of trees intended to assist in the regeneration of a new age class or to make regeneration of a new age class possible. Regeneration harvest may be through even-aged or uneven-aged methods.

regeneration method the cutting approach used to regenerate a stand. Example methods include clearcut, seedtree and shelterwood cutting methods.

relative return on investment ROI is a means to evaluate the conservation benefits of an invasive plant control project in relation to cost (Murdock et al. 2007).

resilience (ecology) the capacity of a (plant or animal) community or ecosystem to maintain or regain normal function and development following disturbance.

resistance the ability of a community to avoid alteration of its present state by a disturbance (Helms 1998)

resource selection function the relative probability of an animal using a unique set of habitat (landscape) characteristics. For studies involving radio-collared animals, “use” of landscape combinations is compared to the “availability” of those combinations in a designated study area.

restocked the condition of the growing space occupancy of trees to be achieved after a disturbance that has substantially altered the existing stocking (see “stocking”).

restoration the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed; ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions (36 Code of Federal Regulations 219.19).

riffle a shallow rapid where the water flows swiftly over completely or partially submerged obstructions (rocks, etc.) to produce surface agitation, but standing waves are absent.

riparian area a three-dimensional ecotone of interaction that include terrestrial and aquatic ecosystems that extend into the groundwater, above the canopy, and outward across the floodplain, up the near-slopes

that drain to the water, laterally into the terrestrial ecosystem, and along the water course at variable widths.

riparian ecosystem a transition between the aquatic ecosystem and the adjacent upland terrestrial ecosystem. A riparian ecosystem is identified by soil characteristics and by distinctive vegetative communities that require free or unbounded water.

riparian management zone Riparian management zones (RMZs) are portions of watersheds where riparian-associated resources receive primary emphasis, and management activities are subject to specific plan components including standards and guidelines. RMZs include traditional riparian corridors, wetlands, intermittent streams, and other areas that maintain the integrity of aquatic ecosystems. RMZs shall be delineated on the ground based on site conditions as follows:

- **Category 1** Fish-bearing streams: RMZs consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.
- **Category 2** Permanently flowing non-fish bearing streams: RMZs consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.
- **Category 3** *Constructed ponds and reservoirs, and wetlands greater than 1 acre* – RMZs consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.
  Lakes and natural ponds - RMZs consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance, whichever is greatest.
- **Category 4** *Seasonally flowing or intermittent streams, wetlands, seeps and springs less than 1 acre, and unstable and potentially unstable areas* - This category applies to features with high variability in size and site-specific characteristics. At a minimum, the RMZs should include:
  - The extent of unstable and potentially unstable areas (including earthflows).
  - The stream channel and extend to the top of the inner gorge.
  - The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, extending from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest. A site-potential tree height is the average maximum height of the tallest dominant trees for a given site class.
  - Intermittent streams are defined as any non-permanent flowing drainage feature having a definable channel and evidence of annual scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two physical criteria. Fish-bearing intermittent streams are distinguished from non-fish-bearing intermittent streams by the presence of any species of fish for any duration. Many intermittent streams may be used as spawning and rearing streams, refuge areas during flood events in larger rivers and streams

or travel routes for fish emigrating from lakes. In these instances, the guidelines for fish-bearing streams would apply to those sections of the intermittent stream used by the fish.

In order to achieve watershed desired conditions, the RMZ is broken into two areas called the inner and outer RMZs. Some activities are prohibited or restricted in the inner RMZ, whereas more active management is allowed in the outer RMZ. RMZs are not intended to be "no touch zones," but rather "carefully managed zones" with an increase in protections in close proximity to water resources.

riparian wildlife habitat an environment that occurs along lakes, rivers, streams, springs, and seeps where the vegetation and microclimate are influenced by year-round or seasonal water and associated high water tables. Plant and animal species in these areas are more productive and diverse than on nearby uplands, making these areas very important to many wildlife species.

road a motor vehicle route more than 50 inches wide, unless identified and managed as a trail. (36 Code of Federal Regulations 212.1, FS Manual 7705):

- decommissioned: The stabilization and restoration of an unneeded road to a more natural state (36 Code of Federal Regulations 212.1).
- forest road or trail: A route wholly or partly within or adjacent to and serving the NFS that is necessary for the protection, administration, and utilization of the NFS and the use and development of its resources (36 Code of Federal Regulations 212.1 – Definitions)
- impassable: A road that has been treated in such a manner that the road is blocked and there is little resource risk if road maintenance is not performed on a regular basis (self-maintaining).
- intermittent stored service/intermittent service road, closed to traffic: The road is in a condition that there is little resource risk if maintenance is not performed.
- maintenance level: A term for the level of service provided by, and maintenance required for, a specific road, consistent with road management objectives and maintenance criteria (FS Handbook 7709.59, 62.32)

  Level 1: These are roads that have been placed in storage between intermittent uses. The period of storage must exceed 1 year. Basic custodial maintenance is performed to prevent damage to adjacent resources and to perpetuate the road for future resource management needs. Emphasis is normally given to maintaining drainage facilities and runoff patterns.

  Level 2: Assigned to roads open for use by high clearance vehicles. Passenger car traffic, user comfort, and user convenience are not considerations.

  Level 3: Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities

  Level 4: Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds

  Level 5: Assigned to roads that provide a high degree of user comfort and convenience.

- NFS: A forest road other than a road which has been authorized by a legally documented right-of-way held by a State, county, or other local public road authority (36 Code of Federal Regulations 212.1)

- temporary: A road necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a forest road and that is not included in a forest transportation atlas (36 Code of Federal Regulations 212.1

rotation the number of years (including the regeneration period) required to establish and grow timber under an even-aged management system to a specified condition or maturity for regeneration harvest.

salvage harvest The removal of dead trees or trees being damaged or dying due to injurious agents other than competition, to recover value that would otherwise be lost.

sanitation cutting or removal of trees to improve stand health by stopping or reducing the actual or anticipated spread of insects and disease.

sapling a young tree that is larger than a seedling but smaller than a pole or small tree; typically 5 to about 25 feet tall and 1 to 5 inches diameter breast height.

savanna a lowland grassland with a scattering of trees. Widely scattered trees are present with less than 10% tree canopy cover and the understory is dominated by grass and/or shrubs.

sawtimber a collection of logs cut from trees with minimum diameter (typically greater than 6 or 7 inches diameter breast height) or trees of the same minimum diameter and of sufficient length and stem quality suitable for conversion to lumber.

scarification the removal of the surface organic material (duff) of an area, typically to prepare the site for reforestation.

scenery management system describes the existing and desired conditions of scenic character within a plan area

scenic character a combination of the physical, biological, and cultural images that gives an area its scenic identity and contributes to its sense of place; scenic character provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity.

scenic integrity objectives a measure of the degree to which a landscape is visually perceived to be complete when compared to the scenic character of that area.

- very high: Landscapes where the valued landscape character “is” intact with minute if any deviations. The existing landscape character and sense of place is expressed at the highest possible level. These landscapes generally provide for ecological change only.
- high: Landscapes in which the valued landscape character “appear” intact. Deviations may be present but must repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such a scale that they are not evident. Management activities do not dominate the landscape.
- moderate: Landscapes in which the valued landscape character “appears slightly altered”. Noticeable deviations must remain visually subordinate to the landscape character being viewed. Management activities are subordinate to the attributes described within the described scenic character of the area.
- low: Landscapes in which the valued landscape character “appears altered”. Deviations begin to dominate the landscape character being viewed but borrow valued attributes such as size, shape, edge effect and pattern of natural openings vegetation type changes or architectural styles outside of

the landscape being viewed. Management activities are visible and sometimes dominant features on the landscape.

- very low: Landscape where the valued landscape character "appears heavily altered". Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes such as sized, shape, edge effect and pattern of natural opening, vegetative type changes or architectural styles within or outside of the landscape being viewed. Management activities are visible and dominate the views of the overall landscape.

scion a detached living portion of a plant, such as a bud or shoot, often a branch tip, that is grafted onto the root-bearing part of another plant.

security habitat an area with low levels of human disturbance or habitat that allows a wildlife species to remain in a defined area despite an increase in stress or disturbance. The components of security habitat can include vegetation, topography, the size of the patches of vegetation, road density, distance from roads, intensity of the disturbance, and seasonal timing of the disturbance. This general definition covers most uses of the term security habitat, except for elk and grizzly bear, which have specific definitions.

sediment solid material, both mineral and organic, that is in suspension, being transported, or has been moved from its site of origin by air, water, gravity, or ice.

seedling a young tree that has just germinated but has not yet reached sapling size, typically 1 to 5 feet tall.

seedling/sapling a size category for forest stands in which trees less than 5 inches in diameter and less than about 25 feet tall are the predominant vegetation.

seedtree method a cutting technique used to regenerate a stand in which nearly all trees are removed from an area, except for a small number of trees that are left singly or in small groups.

seedtree with reserves the application of the seedtree method with the intention of retaining or reserving all or a portion of the seed trees for future stand structure.

selection method a cutting technique used to regenerate a forest stand and maintain an uneven-aged structure, by periodically removing some trees within multiple size classes either singly or in small groups or strips.

seral a biotic community that is developmental; a transitory stage in an ecologic succession.

seral/structural stage a phase of development of an ecosystem in ecological succession from a disturbed, relatively unvegetated state to a complex, mature plant community.

shade-intolerant a plant species that does not grow well or dies from the effects of too much shade.

shade-tolerant a plant species that can develop and grow successfully in the shade of other plants.

shelterwood method a cutting technique used to regenerate an even-aged stand in which some of the mature trees are left to provide protection for regeneration species (greater numbers of trees are left in this method than with the seedtree method). This technique may be performed uniformly throughout the stand, in strips, or in groups. Regeneration may be natural or artificial (planting).

shelterwood with reserves the application of the shelterwood cutting technique with the intention of retaining or reserving all or a portion of the shelterwood trees for future stand structure.

silvicultural diagnosis the compiling, summarizing, evaluation and analyzing of forest stand and/or landscape data. Includes describing desired conditions, interpreting management direction and determining feasible alternative silvicultural systems and initial treatments. Integrates other resource conditions and considerations, such as soils, wildlife habitat and visual sensitivity.

silvicultural prescription a written document that describes management activities needed to implement one or more silvicultural treatments, or a treatment sequence. The prescription documents the results of the analysis during the diagnosis phase.

silvicultural system a management process whereby forests are tended, harvested, and replaced, resulting in a forest of distinctive form. It includes cultural management practices performed during the life of the stand, such as regeneration cutting, thinning, and use of genetically improved tree seeds and seedlings to achieve multiple resource benefits.

silviculture the theory and practice of controlling the establishment, composition, growth, and quality of forest stands in order to achieve the objectives of management.

site preparation a general term for a variety of activities that remove competing vegetation, slash, and other debris that may inhibit the reforestation effort.

site productivity the combined effect of physical and climate properties, soil depth, texture, nutrient load, precipitation, temperature, slope, elevation, and aspect, on tree growth of a specific area of land.

ski area a site and attendant facilities expressly developed to accommodate alpine or Nordic skiing and from which the preponderance of revenue is generated by the sale of lift tickets and fees for ski rentals, for skiing instruction and trail passes for the use of permittee-maintained ski trails. A ski area may also include ancillary facilities directly related to the operation and support of skiing activities (36 Code of Federal Regulations 251.51).

slash the residue left on the ground after felling and other silvicultural operations, or that has accumulated there as a result of storms, fire, or natural pruning.

snag a standing dead tree usually greater than 5 feet in height and 6 inches in diameter breast height.

species of conservation concern a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area (36 Code of federal Regulations 219.9(c)).

stand a community of trees occupying a specific area and sufficiently uniform in canopy composition , age, and size class to be a distinguishable unit, forming a single management entity.

standard (STD) a mandatory constraint on project and activity decision making, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements. Also see chapter 1.

stand-replacing disturbance an agent such as fire, blowdown, insect or disease epidemic, or timber harvest, which kills or removes enough trees (usually considered 80% or more of the tree component) to result in an early seral/successional forest.

stem exclusion structural stage (or closed canopy structural stage) a phase when trees initially grow fast and quickly occupy the growing space, creating a closed canopy. Because the trees are tall, little light reaches the forest floor so understory plants (including smaller trees) are shaded and grow more slowly. Species that need full sunlight usually die; shrubs and herbs may become dormant. New trees are precluded by a lack of sunlight or moisture. (Oliver and Larson, 1996) [NRLMD]

stocking a measure of timber stand density as it relates to the optimum or desired density to achieve a given management objective.

storm proofing measures taken to reduce the risk or amount of damage to roads from major storms.

stressor (ecology) see ecosystem stressor

structural stage a particular forest condition, characterized by a set of forest structural characteristics (such as tree diameters, tree heights, tree densities, canopy layers) that is representative of a particular period of stand development. Also see stand initiation structural stage, stem exclusion structural stage, and understory reinitiation structural stage.

structure the organization and physical arrangement of biological elements such as, snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity. Also see forest structure.

substrate a mineral and/or organic material that forms the streambed (stream bottom).

subwatershed a 6th level/12 digit hydrologic unit code watershed. They range in size from 10,000 to 40,000 acres, as defined in the U.S. Geological Survey hierarchical system of watersheds.

succession/successional stage a predictable process of changes in structure and composition of plant and animal communities over time. Conditions of the prior plant community or successional stage create conditions that are favorable for the establishment of the next stage. The different stages in succession are often referred to as “seral,” or “successional” stages.

suitability of lands a determination made regarding the appropriateness of various lands within a plan area for various uses or activities, based on the desired conditions applicable to those lands. The terms suitable and suited and not suitable and not suited can be considered the same.

summer range a part of the overall range of a species where the majority of individuals are located between spring green-up and the first heavy snowfall; in some areas or for some species winter range and summer range may overlap.

sustainability the capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs. For purposes of this part, “ecological sustainability” refers to the capability of ecosystems to maintain ecological integrity; “economic sustainability” refers to the capability of society to produce and consume or otherwise benefit from goods and services including contributions to jobs and market and nonmarket benefits; and “social sustainability” refers to the capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another, and support vibrant communities (36 CFR 219.19).

sustainable recreation the set of recreation settings and opportunities on the NFS that is ecologically, economically, and socially sustainable for present and future generations.

sustained yield limit the amount of timber, meeting applicable utilization standards, "which can be removed from [a] forest annually in perpetuity on a sustained-yield basis" (National Forest Management Act at section 11, 16 United States Code 1611; 36 CFR 219.11(d)(6))). It is the volume that could be produced in perpetuity on lands that may be suitable for timber production. Calculation of the limit includes volume from lands that may be deemed not suitable for timber production after further analysis during the planning process. The calculation of the sustained yield limit is not limited by land management plan desired condition, other plan components, or the planning unit's fiscal capability and organizational capacity. The sustained yield limit is not a target but is a limitation on harvest, except when the plan allows for a departure.

system road see NFS road.

threatened species a species that the Secretary of the Interior or the Secretary of Commerce has determined is likely to become an endangered species within the foreseeable future throughout all, or a significant portion, of its range. Threatened species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act. Threatened species are listed at 50 Code of Federal Regulations sections 17.11, 17.12, and 223.102.

thrust fault is a type of low angle fault, or break in the Earth's crust across which there has been relative movement, in which rocks of lower stratigraphic position are pushed up and over higher strata. They are often recognized because they place older rocks above younger.

timber harvest the removal of trees for wood fiber use and other multiple-use purposes (36 Code of federal Regulations 219.19).

timber harvest the removal of trees for wood fiber use and other multiple-use purposes

timber management the growing of, tending to, commercial harvesting of, and regeneration of crops of trees. [NRLMD]

timber production the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (36 Code of Federal Regulations 219.19).

total maximum daily load is a pollution budget and includes a calculation of the maximum amount of a pollutant that can occur in a waterbody and allocated the necessary reductions to one or more pollutant sources (metals, sediment, turbidity, etc.). A total maximum daily load serves as a planning tool and potential starting point for restoration or protection activities with the ultimate goal of attending or maintaining water quality standards.

total soil resource commitment is the conversion of a productive site to an essentially nonproductive site (0 to 40 percent of natural productivity) for a period of more than 50 years. Examples include system roads, administrative sites, developed campgrounds, rock quarries, mine sites, livestock watering facilities, and home ignition zones.

trail a route 50 inches or less in width or a route over 50 inches wide that is identified and managed as a trail (36 Code of Federal Regulations 212.1).

trail class the prescribed scale of development for a trail, representing its intended design and management standards.

trailhead an area that provides parking for or access to a singular trail or trails through the forest.

transitory range forested lands that are suitable for grazing for a limited time following a complete or partial forest removal

transportation livestock livestock used as pack and saddle stock for travel on NFS lands.

two-aged stand a stand containing two distinctive age classes or cohorts.

underburning a fire that consumes surface fuels but not trees and some large shrubs.

understory the trees and other woody species which grow under a more or less continuous cover of branches and foliage formed collectively by the upper portion of adjacent trees and other woody growth.

understory re-initiation structural stage establishment of a new age class of trees after overstory trees begin to die, are removed, or no longer fully occupy their growing space. The stand of trees begins to stratify into vertical layers, with some small shade-tolerant trees in the understory. [LCAS]

uneven aged stand a stand of trees of three or more distinct age classes, either intimately mixed or in groups.

uneven aged system a planned sequence of treatments designed to regenerate or maintain a timber stand with three or more age classes. Treatments include single-tree, selection, and group selection regeneration methods.

untrammeled a term defined in the context of the Wilderness Act as an area where human influence does not impede the free play of natural forces or interfere with natural processes in the ecosystem.

unique and/or limited ecological sites ecological sites (or their equivalent) that are limited in size/area and/or distribution.

utilization standards utilization standards are specifications for merchantable forest products offered in a timber sale.

vegetation management a process that changes the composition and structure of vegetation to meet specific objectives, using such means as prescribed fire or timber harvest. For the purposes of this decision, the term does not include removing vegetation for permanent developments like mineral operations, ski runs, roads and the like, and does not apply to fire suppression or to wildland fire use.

viable population a population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments. (36 Code of Federal Regulations 219.19)

viewshed the visible portion of the landscape seen from viewpoints. Viewpoints can include residences, recreational facilities, and travelways.

water quality the physical, chemical, and biological properties of water.

water yield the runoff from a watershed, including groundwater outflow.

watershed a region or land area drained by a single stream, river, or drainage network; a drainage basin.

watershed condition the state of a watershed based on physical and biogeochemical characteristics and processes.

watershed condition framework The watershed condition framework is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands.

weighted average/weighted mean similar to an arithmetic mean or average, where instead of all data points contributing equally to the final average, some data points contribute more than others. In the example of patch sizes of early successional seedling/sapling forests, the data point is the patch. Patches are "weighted" by their acreage, and thus larger patches will contribute more to the determination of average than the smaller patches. This statistic gives insight into how large the largest patches really are, and how the individual patches are distributed along the range from smallest to largest patch size.

wetland is an area that under normal circumstances has hydrophytic vegetation, hydric soils, and wetland hydrology.

wild and scenic river a waterway designated by Congress as part of the National Wild and Scenic Rivers System, which was established in the Wild and Scenic Rivers Act of 1968 (16 United States Code 1271, 1271–1287).

wilderness an area of land designated by Congress as part of the National Wilderness Preservation System that was established in the Wilderness Act of 1964 (16 United States Code 1131–1136).

wildfire unplanned ignition of a wildland fire or an escaped prescribed fire. Wildfire includes unplanned fires that are human-caused and those that are naturally-ignited.

wildland fire Any nonstructure fire that occurs in the wildland. There are two types of wildland fire: unplanned (natural or human-caused ignitions) and planned (prescribed fire).

wildland-urban interface a term is defined by the Healthy Forest Restoration Act § 101:

> (A) an area within or adjacent to an at-risk community that is identified in recommendations to the Secretary in a community wildfire protection plan; or
>
> (B) in the case of any area for which a community wildfire protection plan is not in effect—
>
> (i) an area extending 1⁄2-mile from the boundary of an at-risk community;
>
> (ii) an area within 1 1⁄2 miles of the boundary of an at-risk community, including any land that—
>
> (I) has a sustained steep slope that creates the potential for wildfire behavior endangering the at-risk community;
>
> (II) has a geographic feature that aids in creating an effective fire break, such as a road or ridge top; or
>
> (III) is in condition class 3, as documented by the Secretary in the project-specific environmental analysis; and
>
> (iii) an area that is adjacent to an evacuation route for an at-risk community that the Secretary determines, in cooperation with the at-risk community, requires hazardous fuel reduction to provide safer evacuation from the at-risk community.

wildlife security The protection inherent in any situation that allows animals to remain in a defined area despite an increase in stress or disturbance associated with human activities

windthrow a tree or stand of trees that have been blown over by the wind.

winter range the portion of the overall area a species inhabits where the majority of individuals are found from the first heavy snowfall to spring green-up, or during a specific period of winter. In the Rocky Mountains, winter range areas tend to have a relatively low amount of snow cover.

yarding the operation of hauling timber from the stump to a collecting point.

xeric (of an environment or habitat) containing little moisture; very dry.

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Rory Gluekert	Recreation	9
Jonathan LeBlanc	Soils	6
George Liknes	Fisheries	41
Jonathan Olsen	Fire/Fuels	22
Steve Opp	Minerals	24
Denise Pengeroth	Wildlife	34
Arian Randal	Cultural Resources	10
Scott Williams	Air Quality	37

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Agencies/Organizations/Persons to Whom DEIS Sent

This DEIS has been distributed to individuals who specifically requested a copy of the document. In addition, copies have been sent to other federal agencies, federally recognized tribes, state and local governments, and organizations.

The DEIS, DEIS appendices, draft plan and draft plan appendices have been posted to the forest website www.fs.usda.gov/goto/hlc/forestplanrevision. An email notification of the documents availability on the website was sent to over 9,800 addresses on our electronic mailing list and postcard notifications were mailed as well.

The following table displays the required federal agencies to which the documents were sent, as well as the format of the document.

Agency	Hard copy	CD	Web
Director, Planning and Review Advisory Council on Historic Preservation			X
Deputy Director USDA APHIS PPD/EAD			X
Rural Utilities Service			X
National Environmental Coordinator Natural Resources Conservation Services			X
National Agricultural Library Acquisitions and Serials Branch	X	X	X
Chief of Naval Operations Energy and Environmental Readiness Division			X
U.S. Coast Guard, Commandant CG-47 Office of Environmental Management			X
U.S. Army Corps of Engineers Northwestern Division			X
U.S. Environmental Protection Agency Region 8	X		
Director NEPA Policy and Compliance Department of Energy			X
Director, Office of Environmental Policy and Compliance U.S. Department of the Interior	X		X
Northwest Power Planning Council			X
Regional Director, Northwest Mountain Region Federal Aviation Administration			X
Division Administrator Federal Highway Administration			X

Appendix A, Maps

This appendix provides the maps that were used for the analyses. Forestwide maps are displayed first, followed by geographic area maps, followed by recommended wilderness area maps. Each set of geographic area maps includes a land ownership map. This map displays topographic features, roads, and other reference points that may not be displayed on the rest of the maps.

Forestwide Maps

Map Name	Number
Montana State 2016 303 (d) Listed Water Quality Impaired Streams	FW01
Wild and Scenic River Eligibility Study	FW02
Region 1 Broad Potential Vegetation Types	FW03
Grizzly Bear Conservation Strategy Management Zones	FW04
Lynx Habitat	FW05
Communication Sites	FW06
Recommended Wilderness Areas – Alternative A	FW07
Recommended Wilderness Areas – Alternatives B and C	FW08
Recommended Wilderness Areas – Alternative D	FW09

Geographic Area Maps

Map Name	Number
Big Belts Geographic Area	
Land Ownership	BB01
Watersheds	BB02
Lynx Analysis Units	BB03
Existing Summer Recreation Opportunity Spectrum – Alternative A	BB04
Desired Summer Recreation Opportunity Spectrum – Alternatives B and C	BB05
Desired Summer Recreation Opportunity Spectrum – Alternative D	BB06
Desired Summer Recreation Opportunity Spectrum – Alternative E	BB07
Existing Winter Recreation Opportunity Spectrum – Alternative A	BB08
Desired Winter Recreation Opportunity Spectrum – Alternatives B and C	BB09
Desired Winter Recreation Opportunity Spectrum – Alternative D	BB10
Desired Winter Recreation Opportunity Spectrum – Alternative E	BB11
Visual Quality Objectives – Alternative A	BB12
Desired Scenic Integrity Objectives – Alternative B	BB13
Desired Scenic Integrity Objectives – Alternative C	BB14
Desired Scenic Integrity Objectives – Alternative D	BB15
Desired Scenic Integrity Objectives – Alternative E	BB16
Designated Areas – Alternative A	BB17
Designated Areas – Alternatives B and C	BB18
Designated Areas – Alternative D	BB19

Map Name	Number
Designated Areas – Alternative E	BB20
Inventoried Roadless Areas	BB21
Range Allotments	BB22
Lands Where Harvest Could Occur – Alternative A	BB23
Lands Where Harvest Could Occur – Alternatives B and C	BB24
Lands Where Harvest Could Occur – Alternative D	BB25
Lands Where Harvest Could Occur – Alternative E	BB26
Castles Geographic Area	
Land Ownership	CA01
Watersheds	CA02
Lynx Analysis Units	CA03
Existing Summer Recreation Opportunity Spectrum – Alternative A	CA04
Desired Summer Recreation Opportunity Spectrum – Alternatives B, C, and E	CA05
Desired Summer Recreation Opportunity Spectrum – Alternative D	CA06
Existing Winter Recreation Opportunity Spectrum – Alternative A	CA07
Desired Winter Recreation Opportunity Spectrum – Alternatives B and C	CA08
Desired Winter Recreation Opportunity Spectrum – Alternative D	CA09
Desired Winter Recreation Opportunity Spectrum – Alternative E	CA10
Visual Quality Objectives – Alternative A	CA11
Desired Scenic Integrity Objectives – Alternatives B and E	CA12
Desired Scenic Integrity Objectives – Alternative C	CA13
Desired Scenic Integrity Objectives – Alternative D	CA14
Designated Areas – Alternative D	CA15
Inventoried Roadless Areas	CA16
Range Allotments	CA17
Lands Where Harvest Could Occur – Alternative A	CA18
Lands Where Harvest Could Occur – Alternatives B, C, and E	CA19
Lands Where Harvest Could Occur – Alternative D	CA20
Crazies Geographic Area	
Land Ownership	CR01
Watersheds	CR02
Lynx Analysis Units	CR03
Existing Summer Recreation Opportunity Spectrum – Alternative A	CR04
Desired Summer Recreation Opportunity Spectrum – Alternatives B and C	CR05
Desired Summer Recreation Opportunity Spectrum – Alternative D	CR06
Desired Summer Recreation Opportunity Spectrum – Alternative E	CR07
Existing Winter Recreation Opportunity Spectrum – Alternative A	CR08
Desired Winter Recreation Opportunity Spectrum – Alternatives B and C	CR09
Desired Winter Recreation Opportunity Spectrum – Alternative D	CR10

Map Name	Number
Desired Winter Recreation Opportunity Spectrum – Alternative E	CR11
Visual Quality Objectives – Alternative A	CR12
Desired Scenic Integrity Objectives – Alternatives B and E	CR13
Desired Scenic Integrity Objectives – Alternative C	CR14
Desired Scenic Integrity Objectives – Alternative D	CR15
Designated Areas – Alternative D	CR16
Inventoried Roadless Areas	CR17
Range Allotments	CR18
Lands Where Harvest Could Occur – Alternative A	CR19
Lands Where Harvest Could Occur – Alternatives B and C	CR20
Lands Where Harvest Could Occur – Alternative D	CR21
Lands Where Harvest Could Occur – Alternative E	CR22
Divide Geographic Area	
Land Ownership	D01
Watersheds	D02
Lynx Analysis Units	D03
Existing Summer Recreation Opportunity Spectrum – Alternative A	D04
Desired Summer Recreation Opportunity Spectrum – Alternatives B and C	D05
Desired Summer Recreation Opportunity Spectrum – Alternative D	D06
Desired Summer Recreation Opportunity Spectrum – Alternative E	D07
Existing Winter Recreation Opportunity Spectrum – Alternative A	D08
Desired Winter Recreation Opportunity Spectrum – Alternatives B and C	D09
Desired Winter Recreation Opportunity Spectrum – Alternative D	D10
Desired Winter Recreation Opportunity Spectrum – Alternative E	D11
Visual Quality Objectives – Alternative A	D12
Desired Scenic Integrity Objectives – Alternative B	D13
Desired Scenic Integrity Objectives – Alternative C	D14
Desired Scenic Integrity Objectives – Alternative D	D15
Desired Scenic Integrity Objectives – Alternative E	D16
Designated Areas – Alternative A	D17
Designated Areas – Alternatives B and C	D18
Designated areas – Alternative D	D19
Designated Areas – Alternative E	D20
Inventoried Roadless Areas	D21
Range Allotments	D22
Lands Where Harvest Could Occur – Alternative A	D23
Lands Where Harvest Could Occur – Alternatives B and C	D24
Lands Where Harvest Could Occur – Alternative D	D25
Lands Where Harvest Could Occur – Alternative E	D26

Map Name	Number
Elkhorns Geographic Area	
Land Ownership	E01
Watersheds	E02
Lynx Analysis Units	E03
Existing Summer Recreation Opportunity Spectrum – Alternative A	E04
Desired Summer Recreation Opportunity Spectrum – Alternative B	E05
Desired Summer Recreation Opportunity Spectrum – Alternative C	E06
Desired Summer Recreation Opportunity Spectrum – Alternative D	E07
Desired Summer Recreation Opportunity Spectrum – Alternative E	E08
Existing Winter Recreation Opportunity Spectrum – Alternative A	E09
Desired Recreation Opportunity Spectrum – Alternatives B and E	E10
Desired Recreation Opportunity Spectrum – Alternative C	E11
Desired Recreation Opportunity Spectrum – Alternative D	E12
Visual Quality Objectives – Alternative A	E13
Desired Scenic Integrity Objectives – Alternatives B and E	E14
Desired Scenic Integrity Objectives – Alternative C	E15
Desired Scenic Integrity Objectives – Alternative D	E16
Elkhorns Core Non-Mechanized Use Area – Alternative C	E17
Designated Areas – Alternative D	E18
Inventoried Roadless Areas	E19
Range Allotments	E20
Lands Where Harvest Could Occur – Alternative A	E21
Lands Where Harvest Could Occur – Alternatives B, C, and E	E22
Lands Where Harvest Could Occur – Alternative D	E23
Highwoods Geographic Area	
Land Ownership	H01
Watersheds	H02
Lynx Analysis Units	H03
Existing Summer Recreation Opportunity Spectrum – Alternative A	H04
Desired Summer Recreation Opportunity Spectrum – Alternatives B and C	H05
Desired Summer Recreation Opportunity Spectrum – Alternative D	H06
Desired Summer Recreation Opportunity Spectrum – Alternative E	H07
Existing Winter Recreation Opportunity Spectrum – Alternative A	H08
Desired Winter Recreation Opportunity Spectrum – Alternatives B and C	H09
Desired Winter Recreation Opportunity Spectrum – Alternative D	H10
Desired Winter Recreation Opportunity Spectrum – Alternative E	H11
Visual Quality Objectives – Alternative A	H12
Desired Scenic Integrity Objectives – Alternative B	H13
Desired Scenic Integrity Objectives – Alternative C	H14

Map Name	Number
Desired Scenic Integrity Objectives – Alternative D	H15
Desired Scenic Integrity Objectives – Alternative E	H16
Inventoried Roadless Areas	H17
Range Allotments	H18
Lands Where Timber Harvest Could Occur – Alternative A	H19
Lands Where Timber Harvest Could Occur – Alternatives B and C	H20
Lands Where Timber Harvest Could Occur – Alternative D	H21
Lands Where Timber Harvest Could Occur – Alternative E	H22
Little Belts Geographic Area	
Land Ownership	LB01
Watersheds	LB02
Lynx Analysis Units	LB03
Exiting Summer Recreation Opportunity Spectrum – Alternative A	LB04
Desired Summer Recreation Opportunity Spectrum – Alternatives B and C	LB05
Desired Summer Recreation Opportunity Spectrum – Alternative D	LB06
Desired Summer Recreation Opportunity Spectrum – Alternative E	LB07
Existing Winter Recreation Opportunity Spectrum – Alternative A	LB08
Desired Winter Recreation Opportunity Spectrum – Alternatives B and C	LB09
Desired Winter Recreation Opportunity Spectrum – Alternative D	LB10
Desired Winter Recreation Opportunity Spectrum – Alternative E	LB11
Visual Quality Objectives – Alternative A	LB12
Desired Scenic Integrity Objectives – Alternative B	LB13
Desired Scenic Integrity Objectives – Alternative C	LB14
Desired Scenic Integrity Objectives – Alternative D	LB15
Desired Scenic Integrity Objectives – Alternative E	LB16
Designated Areas – Alternative A	LB17
Designated Areas – Alternatives B and C	LB18
Designated Areas – Alternative D	LB19
Designated Areas – Alternative E	LB20
Inventoried Roadless Areas	LB21
Range Allotments	LB22
Lands Where Harvest Could Occur – Alternative A	LB23
Lands Where Harvest Could Occur – Alternatives B and C	LB24
Lands Where Harvest Could Occur – Alternative D	LB25
Lands Where Harvest Could Occur – Alternative E	LB26
Rocky Mountain Range Geographic Area	
Land Ownership	RM01
Watersheds	RM02
Lynx Analysis Units	RM03

Map Name	Number
Existing Summer Recreation Opportunity Spectrum – Alternative A	RM04
Desired Summer Recreation Opportunity Spectrum – Alternatives B, C, and E	RM05
Desired Summer Recreation Opportunity Spectrum – Alternative D	RM06
Existing Winter Recreation Opportunity Spectrum – Alternative A	RM07
Desired Winter Recreation Opportunity Spectrum – Alternatives B, C, and E	RM08
Desired Winter Recreation Opportunity Spectrum – Alternative D	RM09
Visual Quality Objectives –Alternative A	RM10
Desired Scenic Integrity Objectives – Alternative B	RM11
Desired Scenic Integrity Objectives – Alternative C	RM12
Desired Scenic Integrity Objectives – Alternative D	RM13
Desired Scenic Integrity Objectives – Alternative E	RM14
Designated Areas – Alternative A	RM15
Designated Areas – Alternatives B, C, D, and E	RM16
Inventoried Roadless Areas	RM17
Range Allotments	RM18
Lands Where Harvest Could Occur – Alternative A	RM19
Lands Where Harvest Could Occur – Alternatives B, C, and E	RM20
Lands Where Harvest Could Occur – Alternative D	RM21
Snowies Geographic Area	
Land Ownership	S01
Watersheds	S02
Lynx Analysis Units	S03
Existing Summer Recreation Opportunity Spectrum – Alternative A	S04
Desired Summer Recreation Opportunity Spectrum – Alternatives B, C, and D	S05
Desired Summer Recreation Opportunity Spectrum – Alternative E	S06
Existing Winter Recreation Opportunity Spectrum – Alternative A	S07
Desired Winter Recreation Opportunity Spectrum – Alternatives B, C, and D	S08
Desired Winter Recreation Opportunity Spectrum – Alternative E	S09
Visual Quality Objectives – Alternative A	S10
Desired Scenic Integrity Objectives – Alternatives B, C, and D	S11
Desired Scenic Integrity Objectives – Alternative E	S12
Designated Areas – Alternatives A and E	S13
Designated Areas – Alternatives B, C, and D	S14
Inventoried Roadless Areas	S15
Range Allotments	S16
Lands Where Harvest Could Occur - Alternative A	S17
Lands Where Harvest Could Occur, Alternatives B, C, and D	S18
Lands Where Harvest Could Occur – Alternative E	S19
Upper Blackfoot Geographic Area	

Map Name	Number
Land Ownership	UB01
Watersheds	UB02
Lynx Analysis Units	UB03
Existing Summer Recreation Opportunity Spectrum – Alternative A	UB04
Desired Summer Recreation Opportunity Spectrum – Alternatives B, C, and D	UB05
Desired Recreation Opportunity Spectrum – Alternative E	UB06
Existing Winter Recreation Opportunity Spectrum – Alternative A	UB07
Desired Winter Recreation Opportunity Spectrum – Alternatives B, C, and D	UB08
Desired Winter Recreation Opportunity Spectrum – Alternative E	UB09
Visual Quality Objectives – Alternative A	UB10
Desired Scenic Integrity Objectives – Alternatives B and D	UB11
Desired Scenic Integrity Objectives – Alternative C	UB12
Desired Scenic Integrity Objectives – Alternative E	UB13
Designated Areas – Alternatives A and E	UB14
Designated Areas – Alternatives B and C	UB15
Designated Areas – Alternative - D	UB16
Inventoried Roadless Areas	UB17
Range Allotments	UB18
Lands Where Harvest Could Occur – Alternative A	UB19
Lands Where Harvest Could Occur – Alternative B, C, and D	UB20
Lands Where Harvest Could Occur – Alternative E	UB21

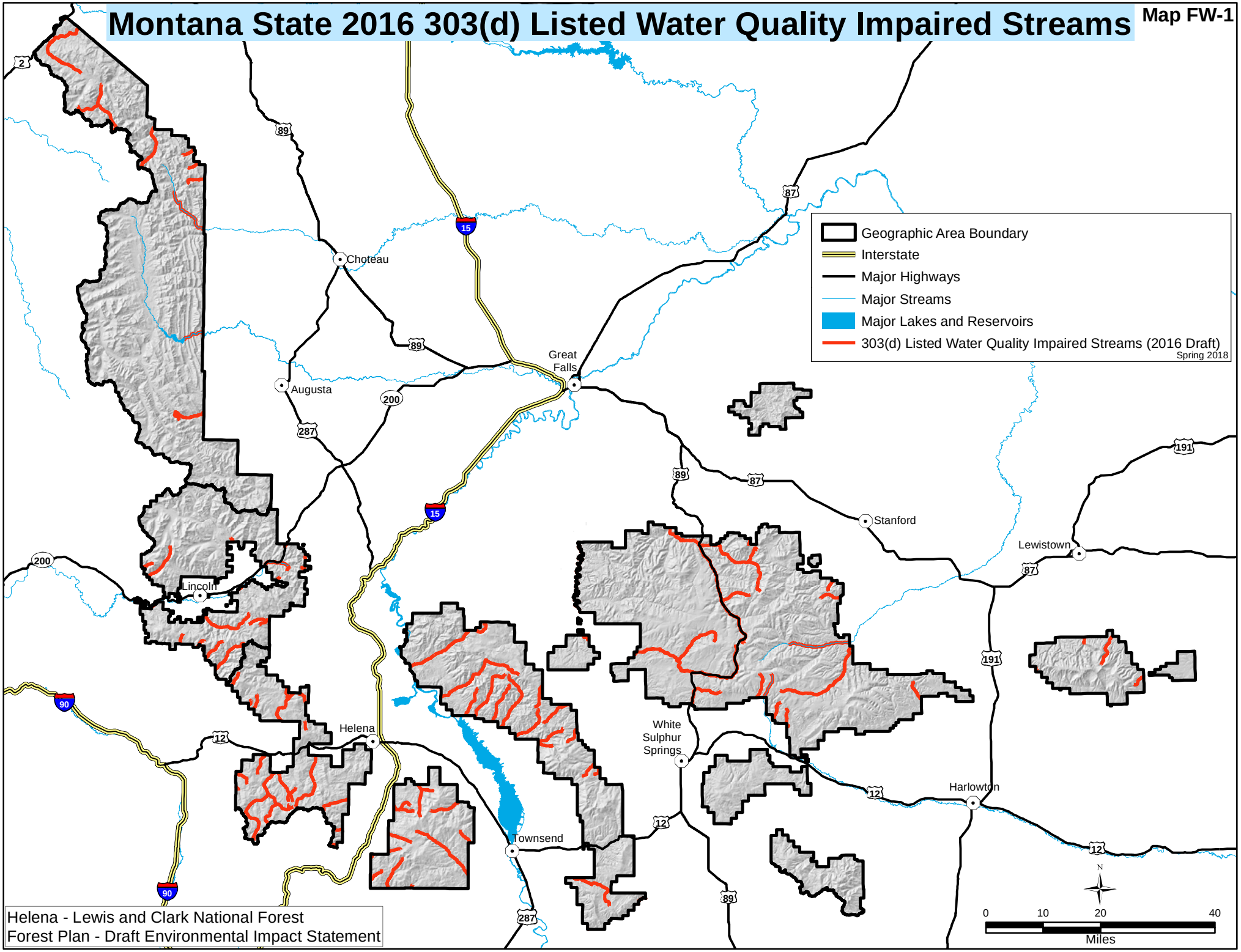
Recommended Wilderness Areas

Map Name	Number
Big Log – Alternative A	RWA01
Big Log – Alternatives B, C, and D	RWA02
Camas Creek – Alternative D	RWA03
Mount Baldy – Alternative A	RWA04
Mount Baldy – Alternatives B, C, and D	RWA05
Wapiti Peak – Alternative D	RWA06
Loco Mountain – Alternative D	RWA07
Electric Peak – Alternative A	RWA08
Blackfoot Meadows – Alternatives B and C	RWA09
Blackfoot Meadows – Alternative D	RWA10
Colorado Mountain – Alternative D	RWA11
Deep Creek – Alternatives B, C, and D	RWA12
Tenderfoot Creek – Alternative D	RWA13
Big Horn Thunder – Alternative D	RWA14
Middle Fork Judith – Alternative D	RWA15

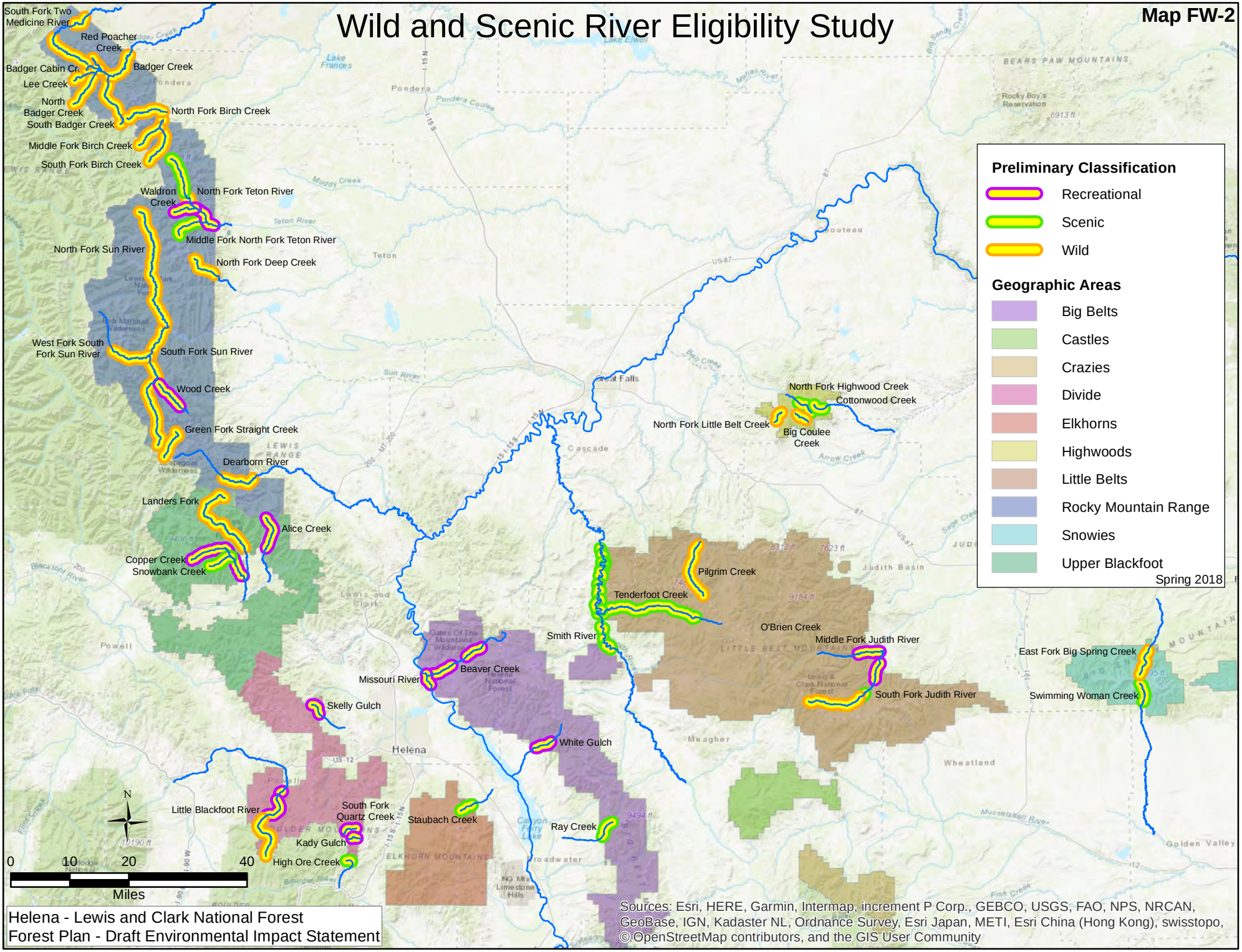
Map Name	Number
Big Snowies – Alternatives B, C, and D	RWA16
Dearborn Silver King – Alternatives B, C, and D	RWA17
Red Mountain – Alternatives B, C, and D	RWA18
Arrastra Creek – Alternatives B, C, and D	RWA19
Nevada Mountain – Alternatives B and C	RWA20
Nevada Mountain – Alternative D	RWA21

Montana State 2016 303(d) Listed Water Quality Impaired Streams

Map FW-1

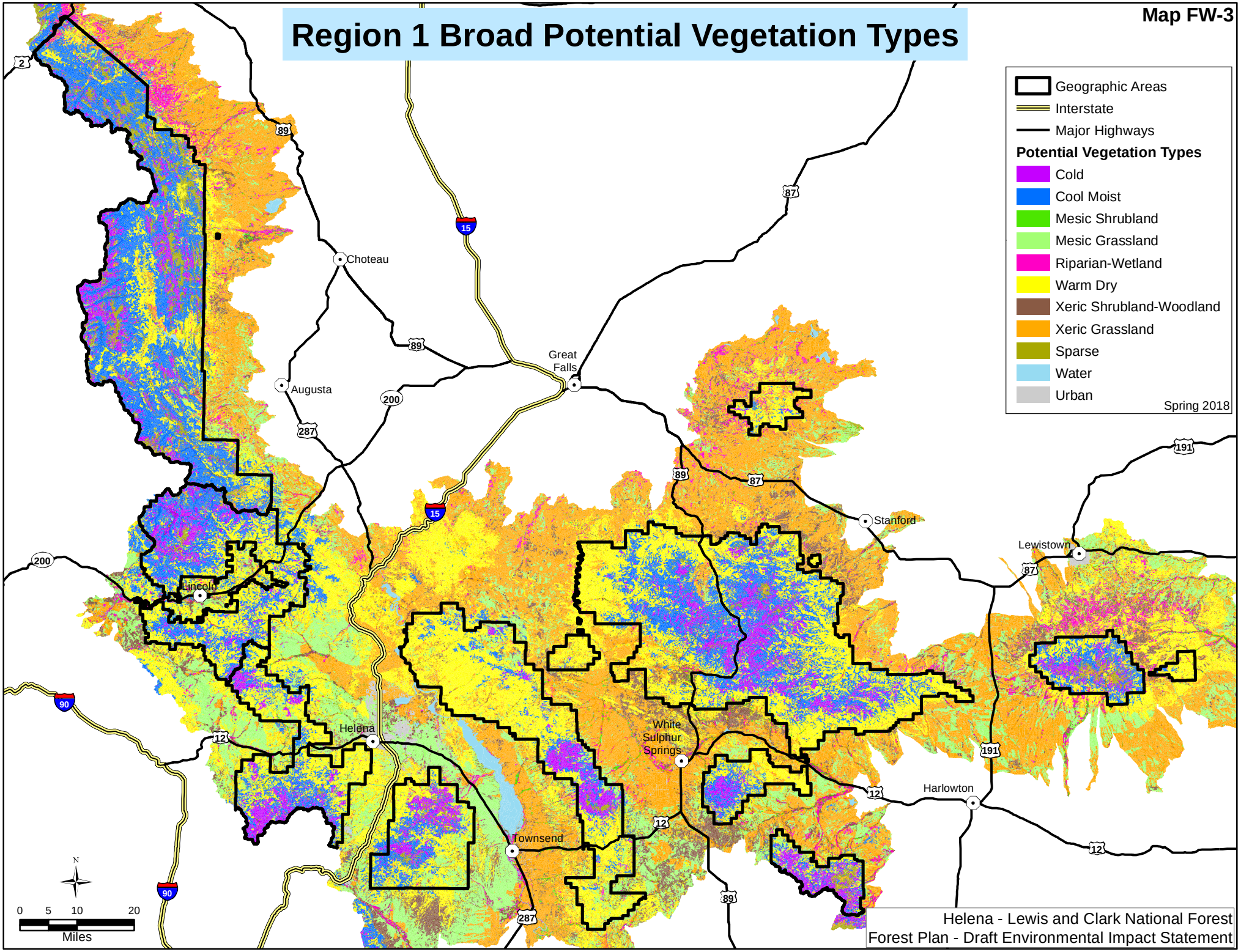


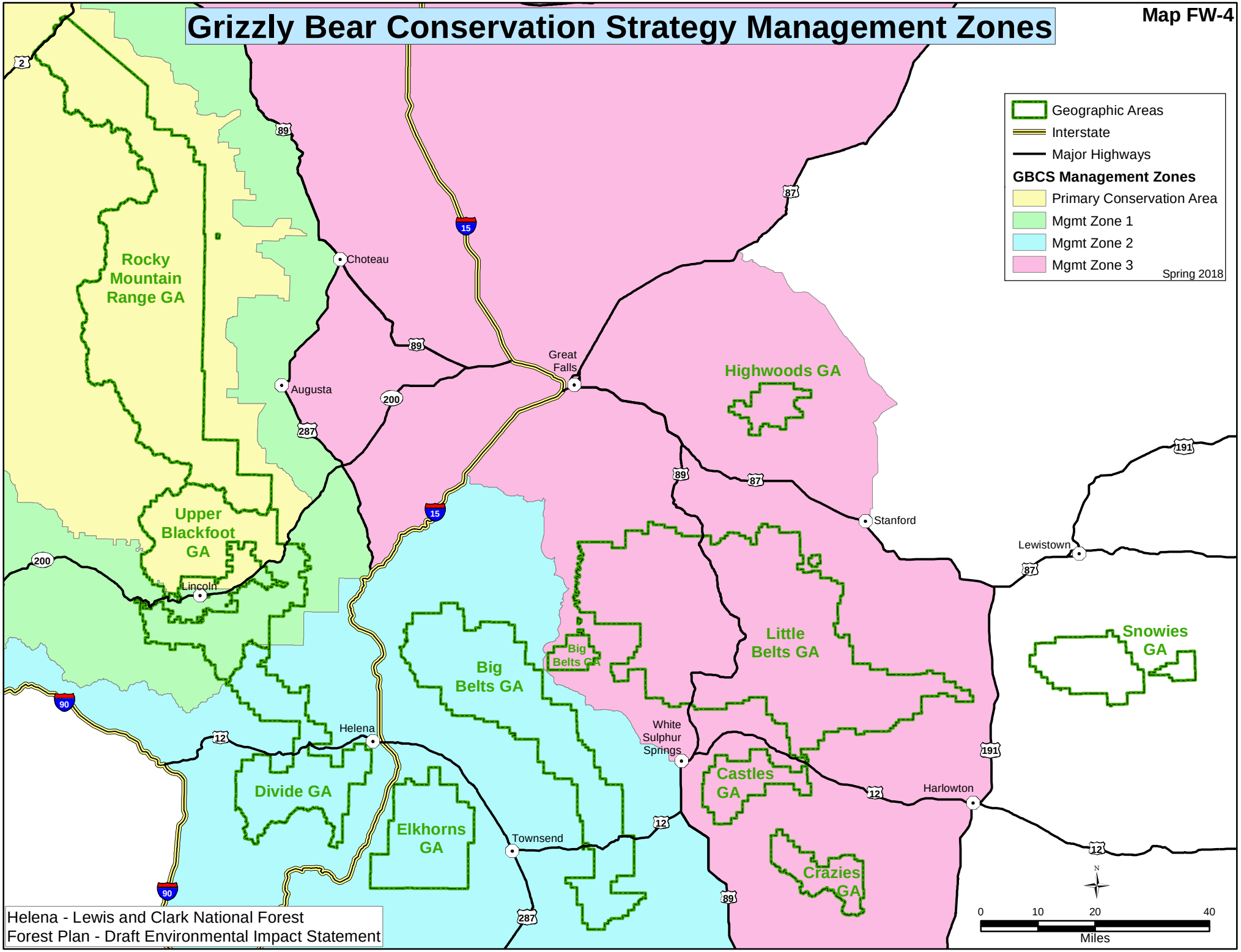
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Wild and Scenic River Eligibility Study
Map FW-2
South Fork Two Medicine River
Red Poacher Creek
Badger Cabin Creek
Badger Creek
Lee Creek
North Badger Creek
South Badger Creek
North Fork Birch Creek
Middle Fork Birch Creek
South Fork Birch Creek
Waldron Creek
North Fork Teton River
Middle Fork North Fork Teton River
North Fork Deep Creek
North Fork Sun River
West Fork South Fork Sun River
South Fork Sun River
Wood Creek
Green Fork Straight Creek
Dearborn River
Landers Fork
Alice Creek
Copper Creek
Snowbank Creek
North Fork Highwood Creek
Cottonwood Creek
North Fork Little Belt Creek
Big Coulee Creek
Pilgrim Creek
Tenderfoot Creek
O'Brien Creek
Middle Fork Judith River
South Fork Judith River
Smith River
Missouri River
Beaver Creek
Skelly Gulch
White Gulch
Ray Creek
Staubach Creek
Little Blackfoot River
South Fork Quartz Creek
Kady Gulch
High Ore Creek
East Fork Big Spring Creek
Swimming Woman Creek
Preliminary Classification
Recreational
Scenic
Wild
Geographic Areas
Big Belts
Castles
Crazies
Divide
Elkhorns
Highwoods
Little Belts
Rocky Mountain Range
Snowies
Upper Blackfoot
Spring 2018
N
0 10 20 40
Miles
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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

Region 1 Broad Potential Vegetation Types

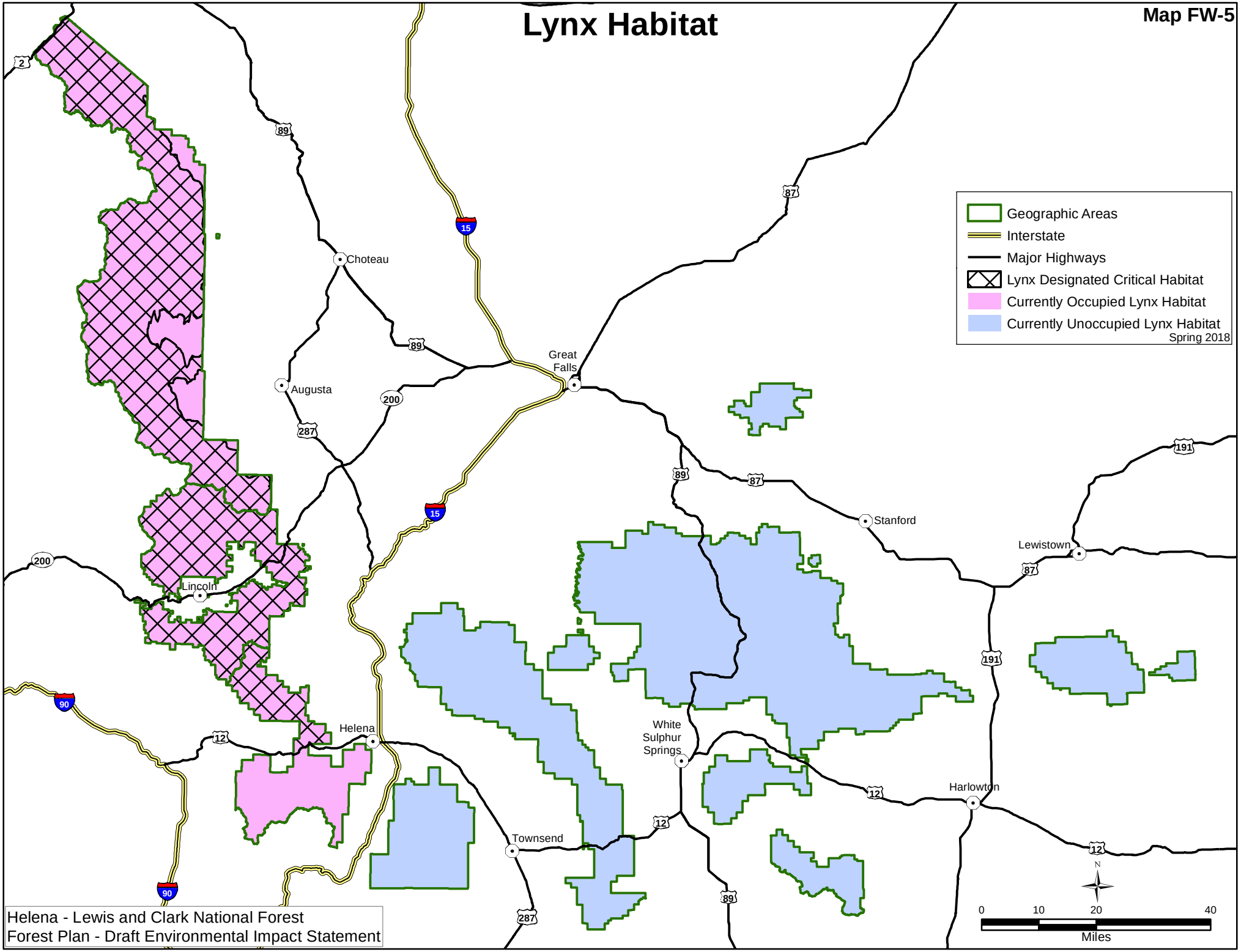
Map FW-3



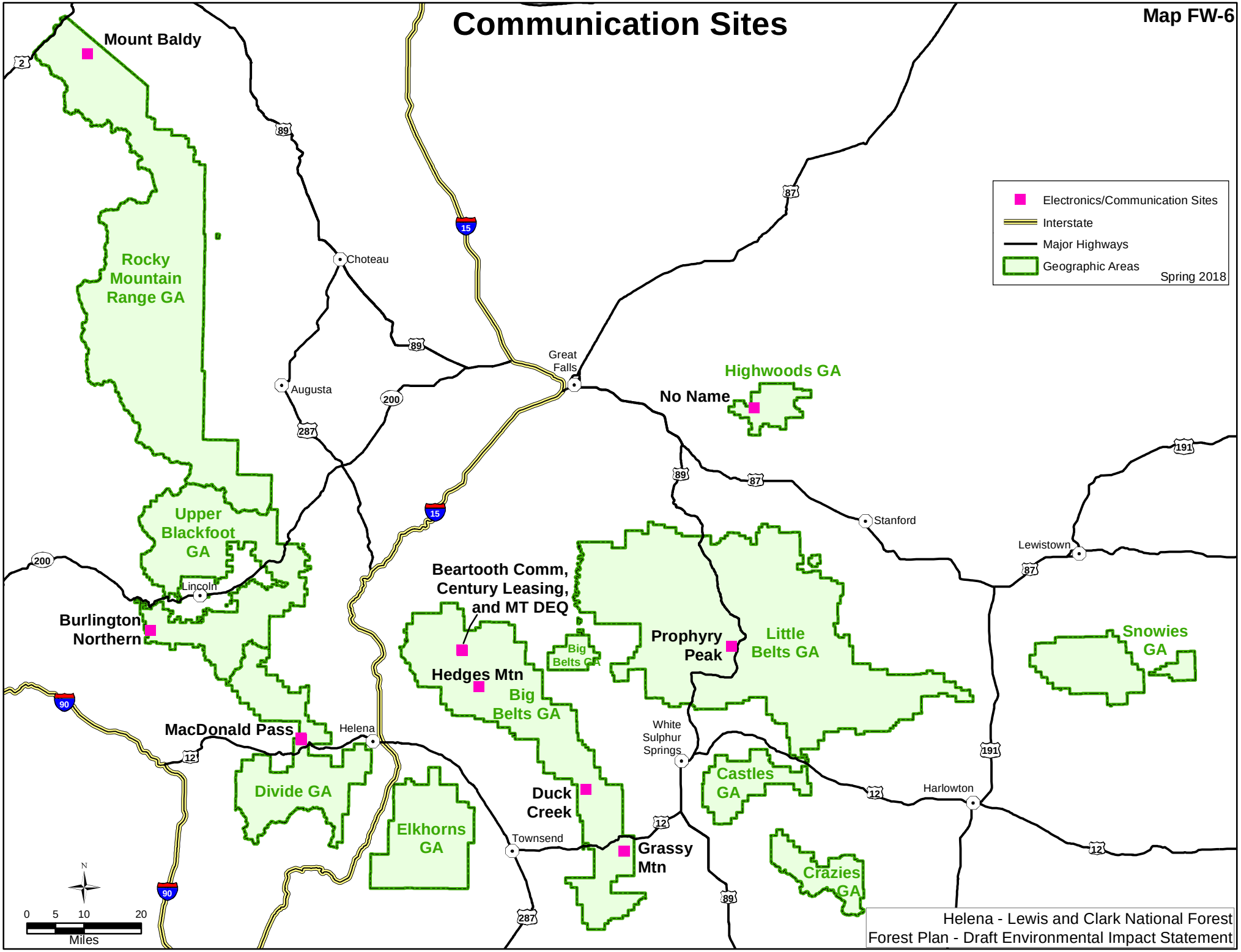

Grizzly Bear Conservation Strategy Management Zones
Map FW-4
Geographic Areas
Interstate
Major Highways
GBCS Management Zones
Primary Conservation Area
Mgmt Zone 1
Mgmt Zone 2
Mgmt Zone 3
Spring 2018
Rocky Mountain Range GA
Upper Blackfoot GA
Highwoods GA
Big Belts GA
Big Belts GA
Little Belts GA
Snowies GA
Castles GA
Crazies GA
Divide GA
Elkhorns GA
Choteau
Great Falls
Augusta
Stanford
Lewistown
Lincoln
Helena
White Sulphur Springs
Harlowton
Townsend
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0 10 20 40
Miles

Lynx Habitat

Map FW-5

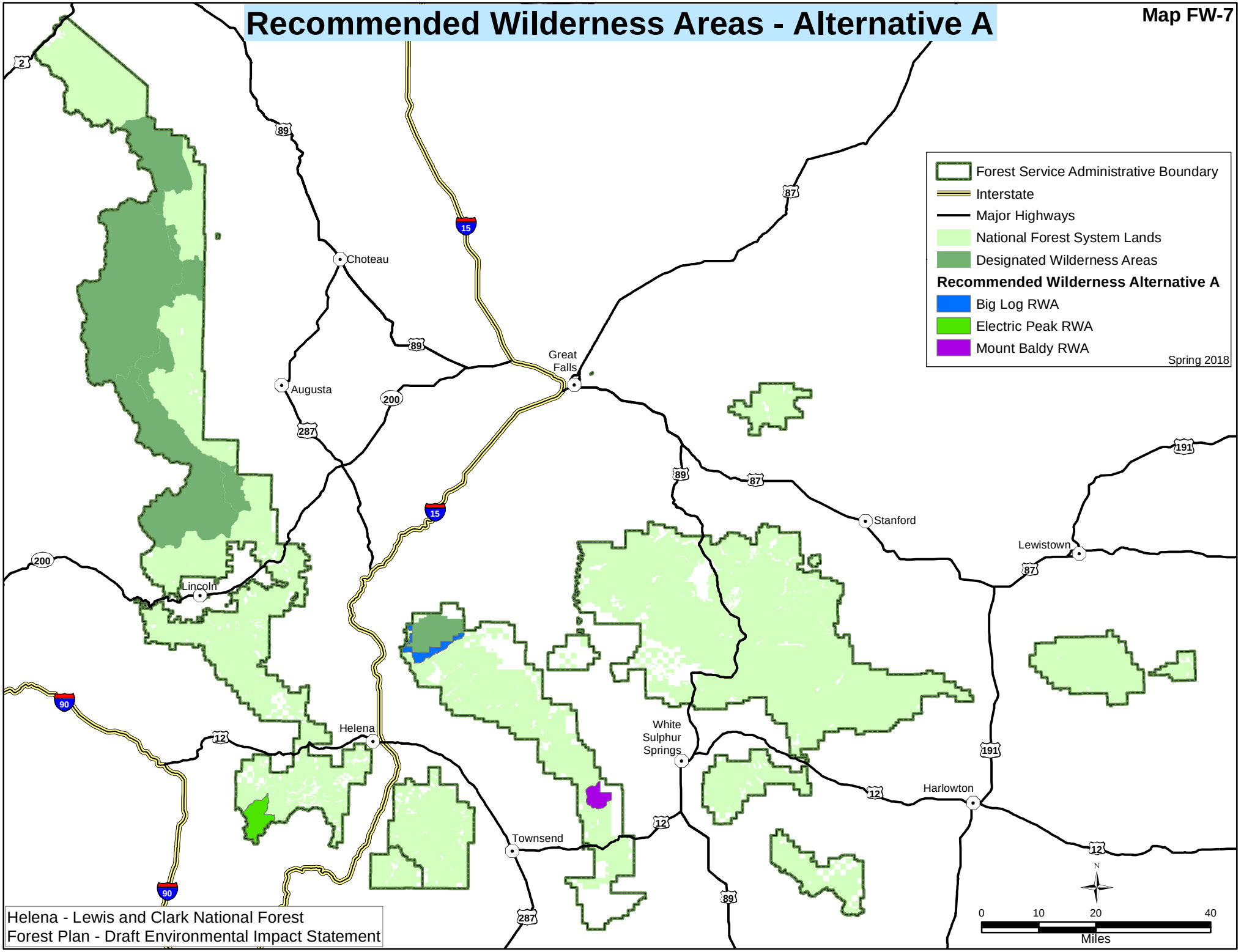


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Communication Sites
Map FW-6
Mount Baldy
Rocky Mountain Range GA
Choteau
Augusta
Great Falls
Highwoods GA
No Name
Upper Blackfoot GA
Lincoln
Burlington Northern
Beartooth Comm, Century Leasing, and MT DEQ
Hedges Mtn
Big Belts GA
Big Belts GA
Prophyry Peak
Little Belts GA
Stanford
Lewistown
Snowies GA
MacDonald Pass
Helena
White Sulphur Springs
Divide GA
Elkhorns GA
Duck Creek
Townsend
Grassy Mtn
Castles GA
Harlowton
Crazies GA
Electronics/Communication Sites
Interstate
Major Highways
Geographic Areas
Spring 2018
N
0 5 10 20
Miles
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Recommended Wilderness Areas - Alternative A

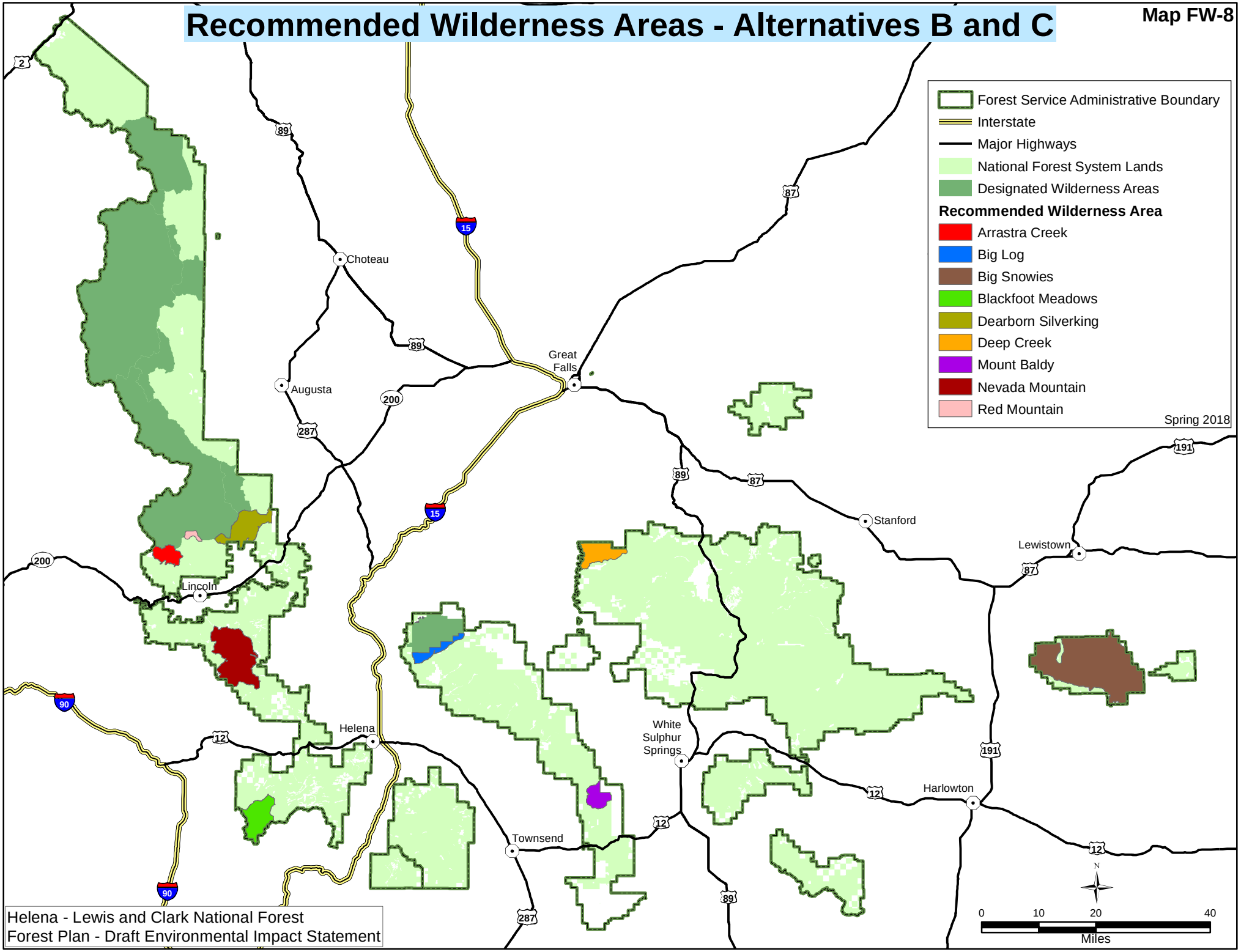
Map FW-7



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Recommended Wilderness Areas - Alternatives B and C

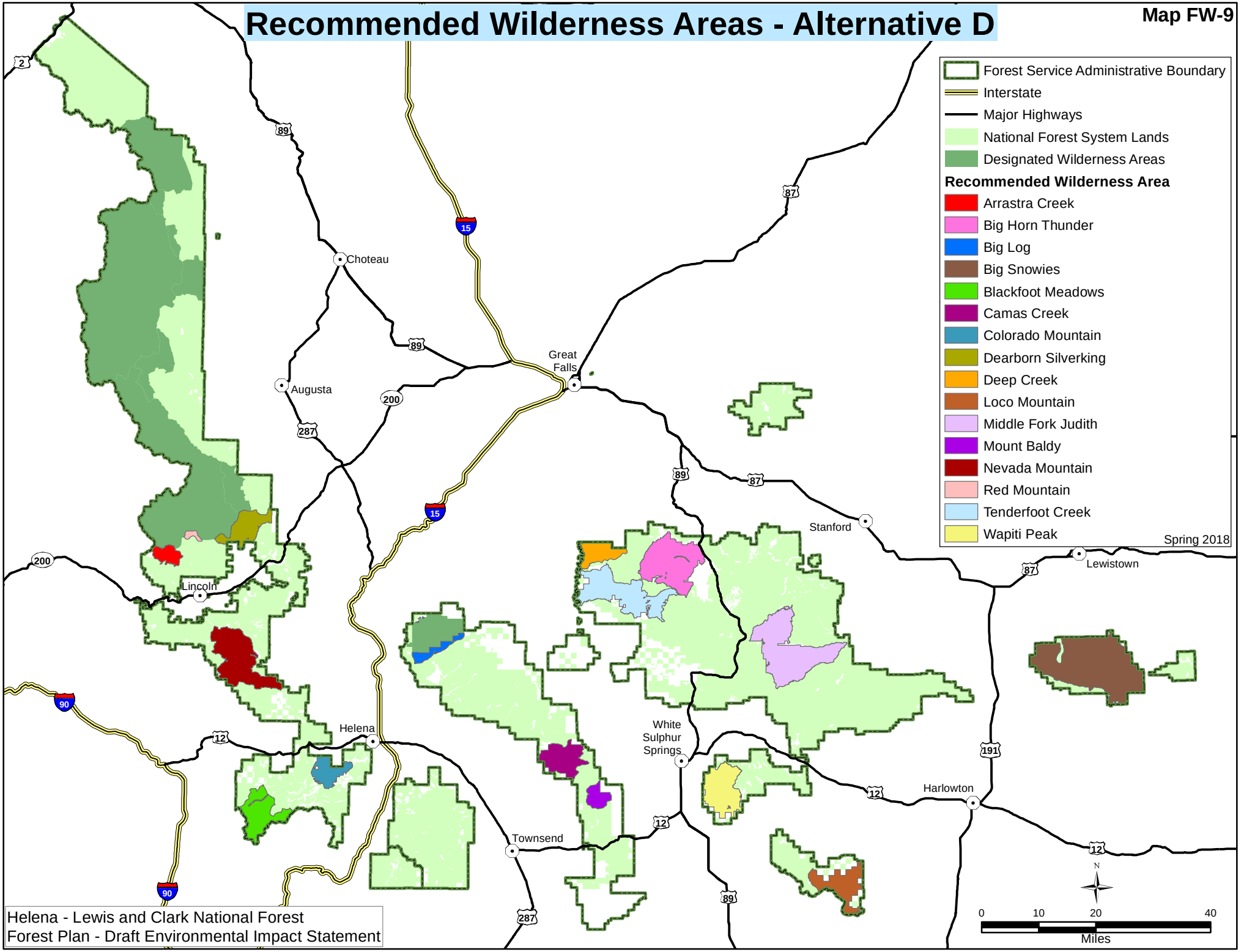
Map FW-8



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Recommended Wilderness Areas - Alternative D

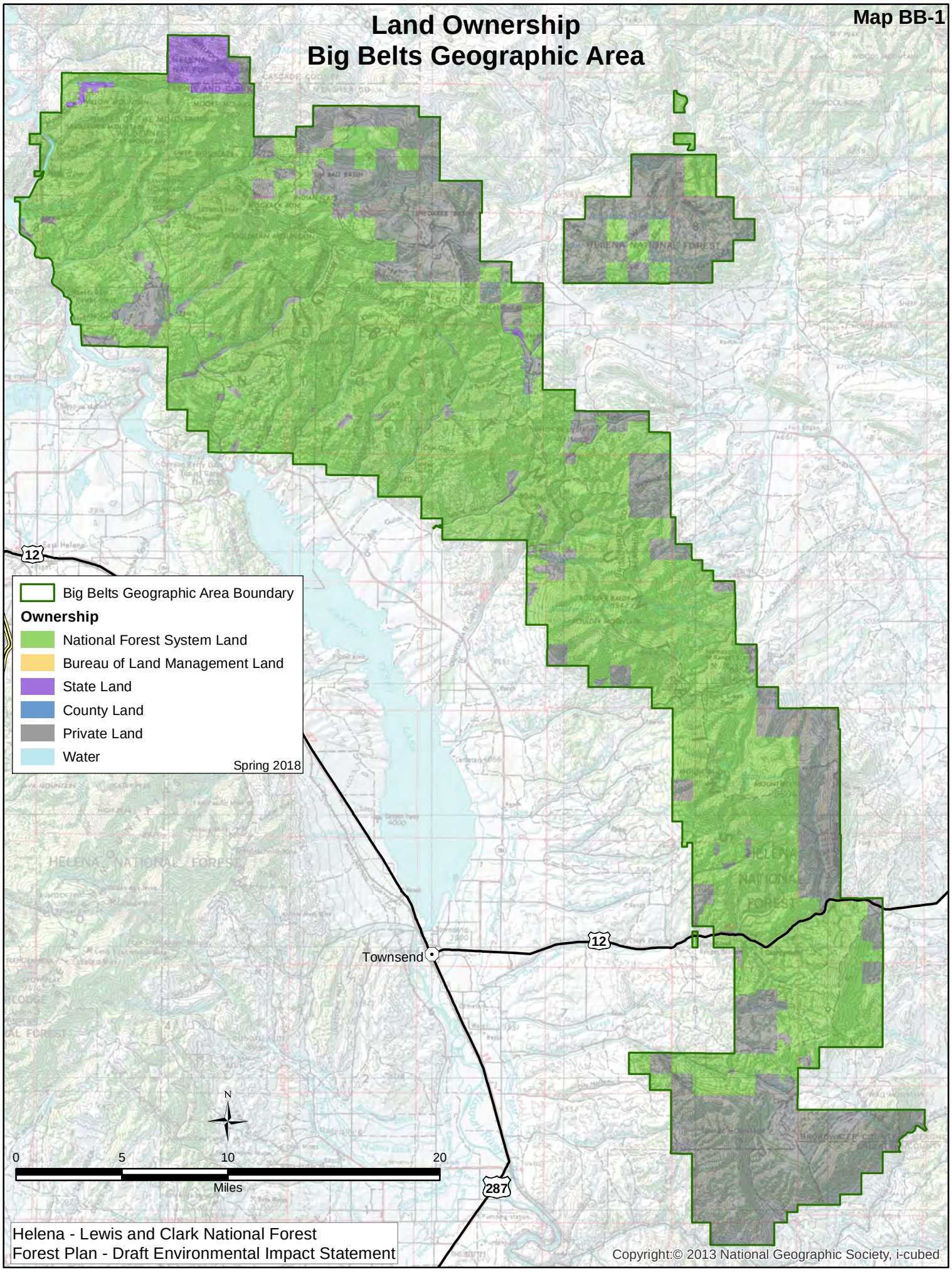
Map FW-9



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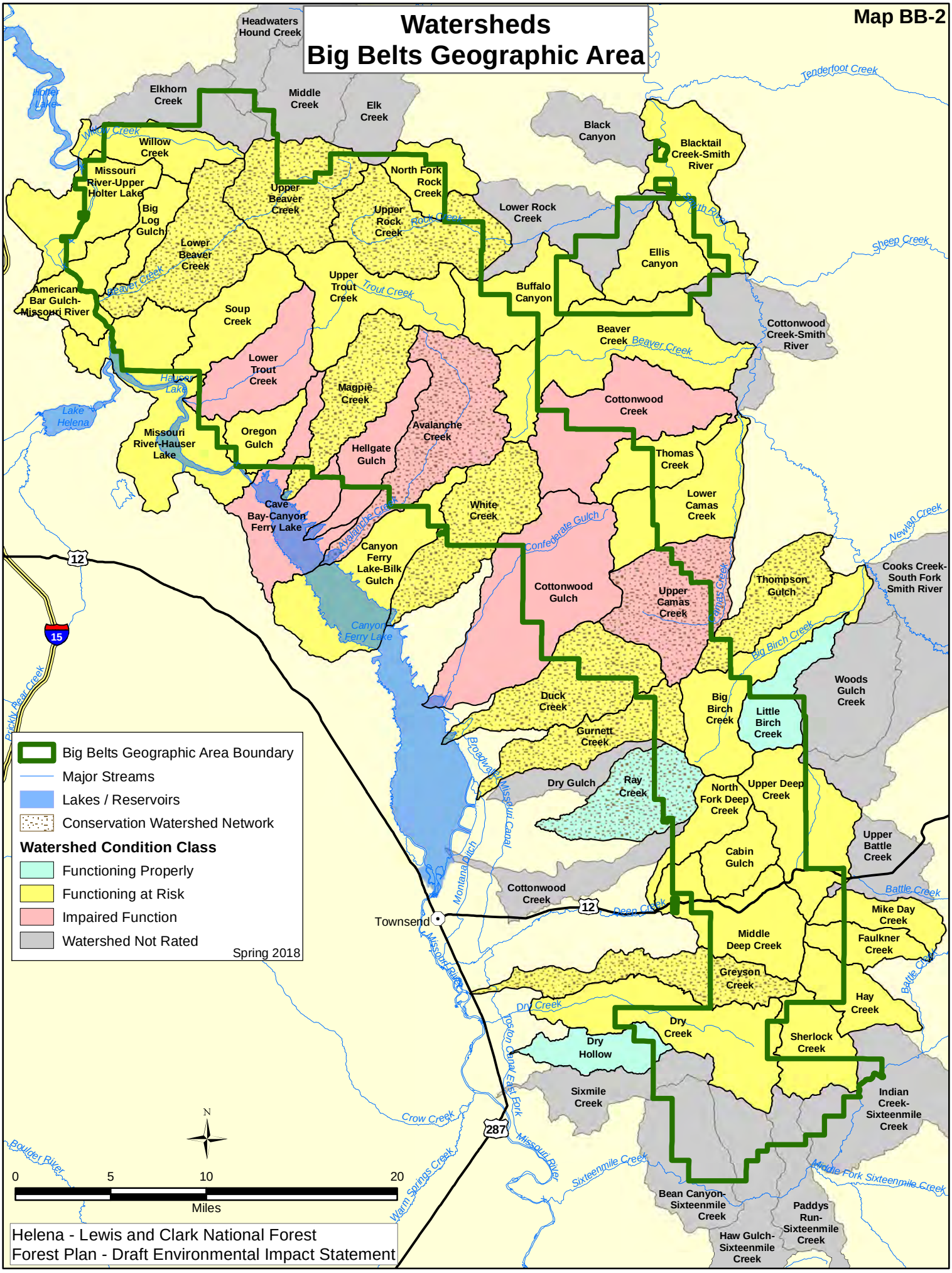
Land Ownership
Big Belts Geographic Area

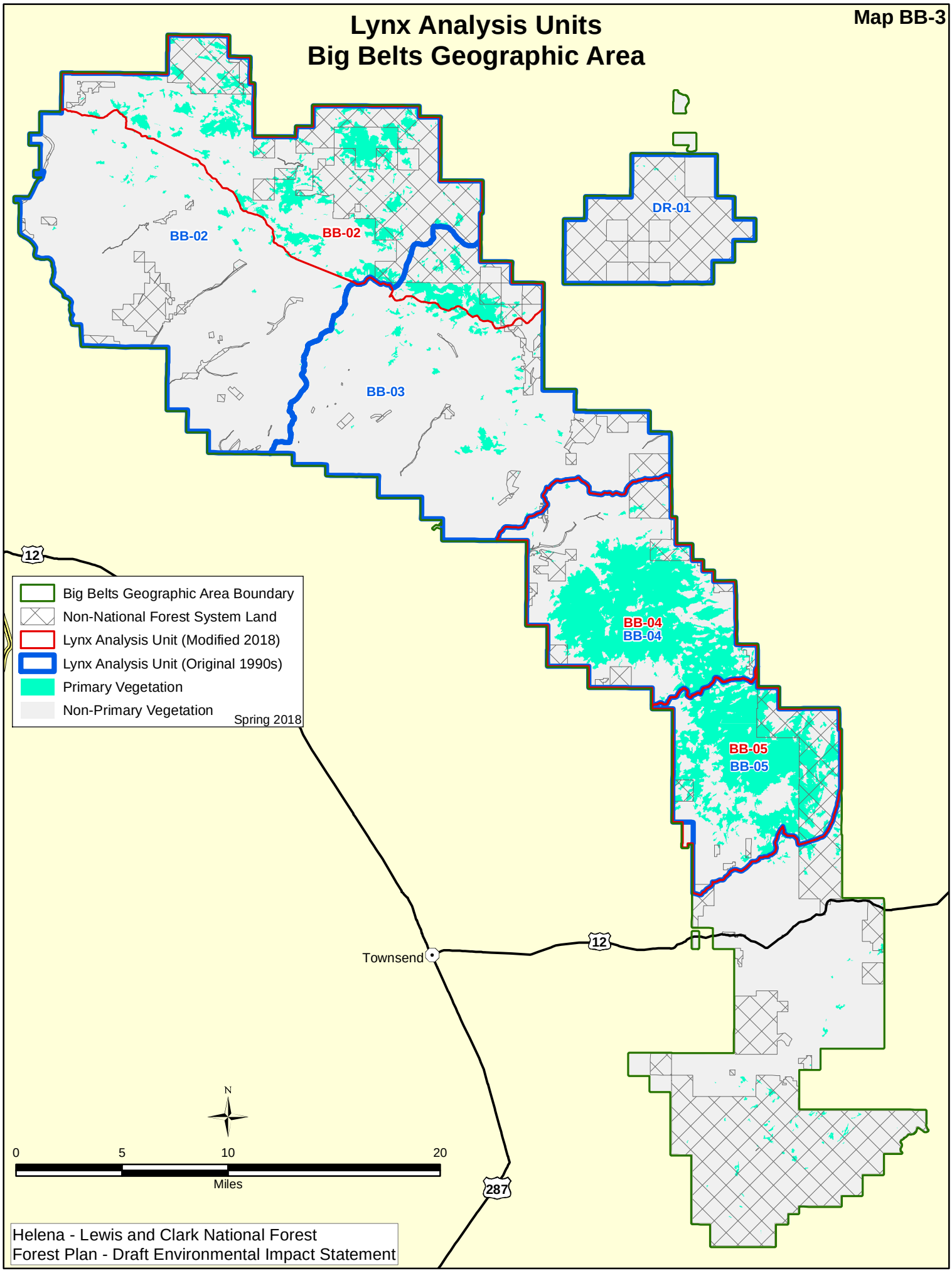
Map BB-1



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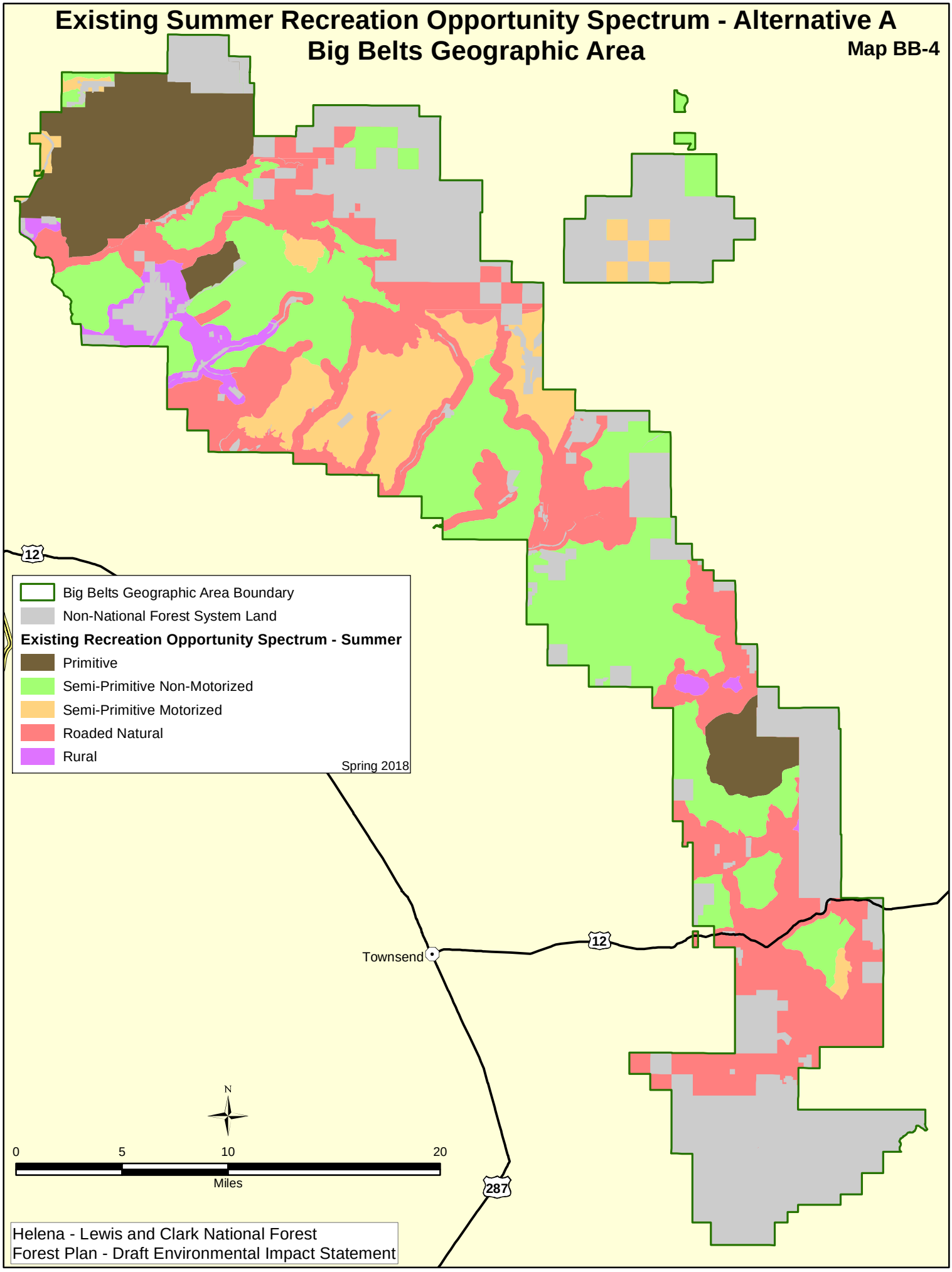
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Watersheds
Big Belts Geographic Area
Map BB-2
Headwaters Hound Creek
Elkhorn Creek
Middle Creek
Elk Creek
Willow Creek
Missouri River-Upper Holter Lake
Big Log Gulch
Upper Beaver Creek
Lower Beaver Creek
North Fork Rock Creek
Upper Rock Creek
Rock Creek
Lower Rock Creek
Black Canyon
Blacktail Creek-Smith River
Ellis Canyon
Sheep Creek
Tenderfoot Creek
Beaver Creek
American Bar Gulch-Missouri River
Soup Creek
Upper Trout Creek
Trout Creek
Buffalo Canyon
Cottonwood Creek-Smith River
Lower Trout Creek
Hauser Lake
Lake Helena
Magpie Creek
Missouri River-Hauser Lake
Oregon Gulch
Hellgate Gulch
Avalanche Creek
Cottonwood Creek
Thomas Creek
Lower Camas Creek
Cave Bay-Canyon Ferry Lake
White Creek
Canyon Ferry Lake-Bilk Gulch
Confederate Gulch
Cottonwood Gulch
Upper Camas Creek
Thompson Gulch
Cooks Creek-South Fork Smith River
Newlan Creek
Canyon Ferry Lake
Big Birch Creek
Woods Gulch Creek
Duck Creek
Big Birch Creek
Little Birch Creek
Gurnett Creek
Broadwater Missouri Canal
Dry Gulch
Ray Creek
North Fork Deep Creek
Upper Deep Creek
Cabin Gulch
Upper Battle Creek
Battle Creek
Cottonwood Creek
Townsend
Deep Creek
Mike Day Creek
Middle Deep Creek
Faulkner Creek
Greyson Creek
Hay Creek
Dry Creek
Dry Creek
Dry Hollow
Sherlock Creek
Boston Canal East Fork
Sixmile Creek
Indian Creek-Sixteenmile Creek
Crow Creek
Missouri River
Sixteenmile Creek
Middle Fork Sixteenmile Creek
Bean Canyon-Sixteenmile Creek
Paddys Run-Sixteenmile Creek
Haw Gulch-Sixteenmile Creek
Warm Springs Creek
Boulder River
Prickly Bear Creek
Big Belts Geographic Area Boundary
Major Streams
Lakes / Reservoirs
Conservation Watershed Network
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018
N
0
5
10
20
Miles
12
15
287
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Map BB-3
Lynx Analysis Units
Big Belts Geographic Area
BB-02
BB-02
DR-01
BB-03
BB-04
BB-04
BB-05
BB-05
12
12
Townsend
287
Big Belts Geographic Area Boundary
Non-National Forest System Land
Lynx Analysis Unit (Modified 2018)
Lynx Analysis Unit (Original 1990s)
Primary Vegetation
Non-Primary Vegetation
Spring 2018
N
0
5
10
20
Miles
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Existing Summer Recreation Opportunity Spectrum - Alternative A
Big Belts Geographic Area

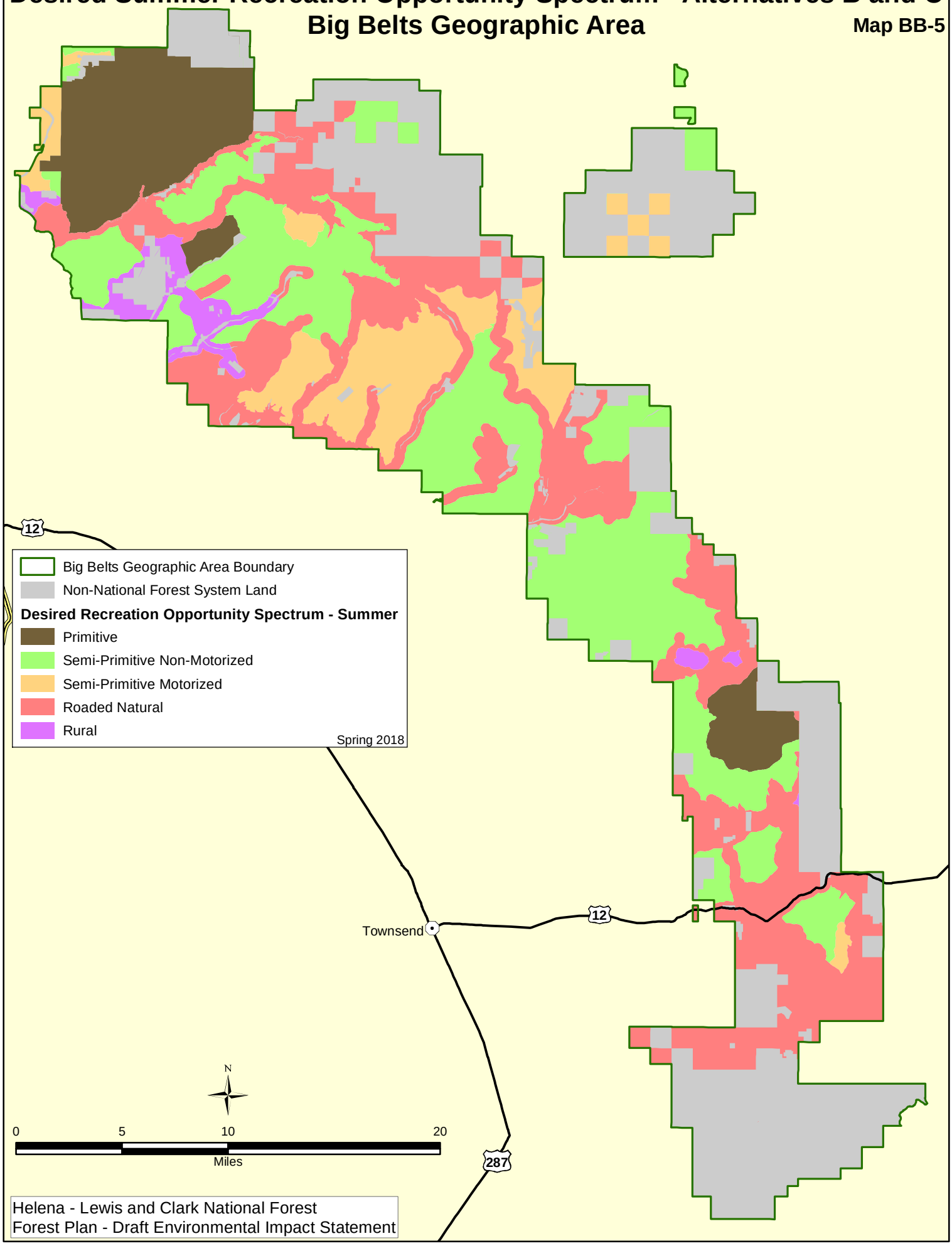
Map BB-4



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Desired Summer Recreation Opportunity Spectrum - Alternatives B and C
Big Belts Geographic Area

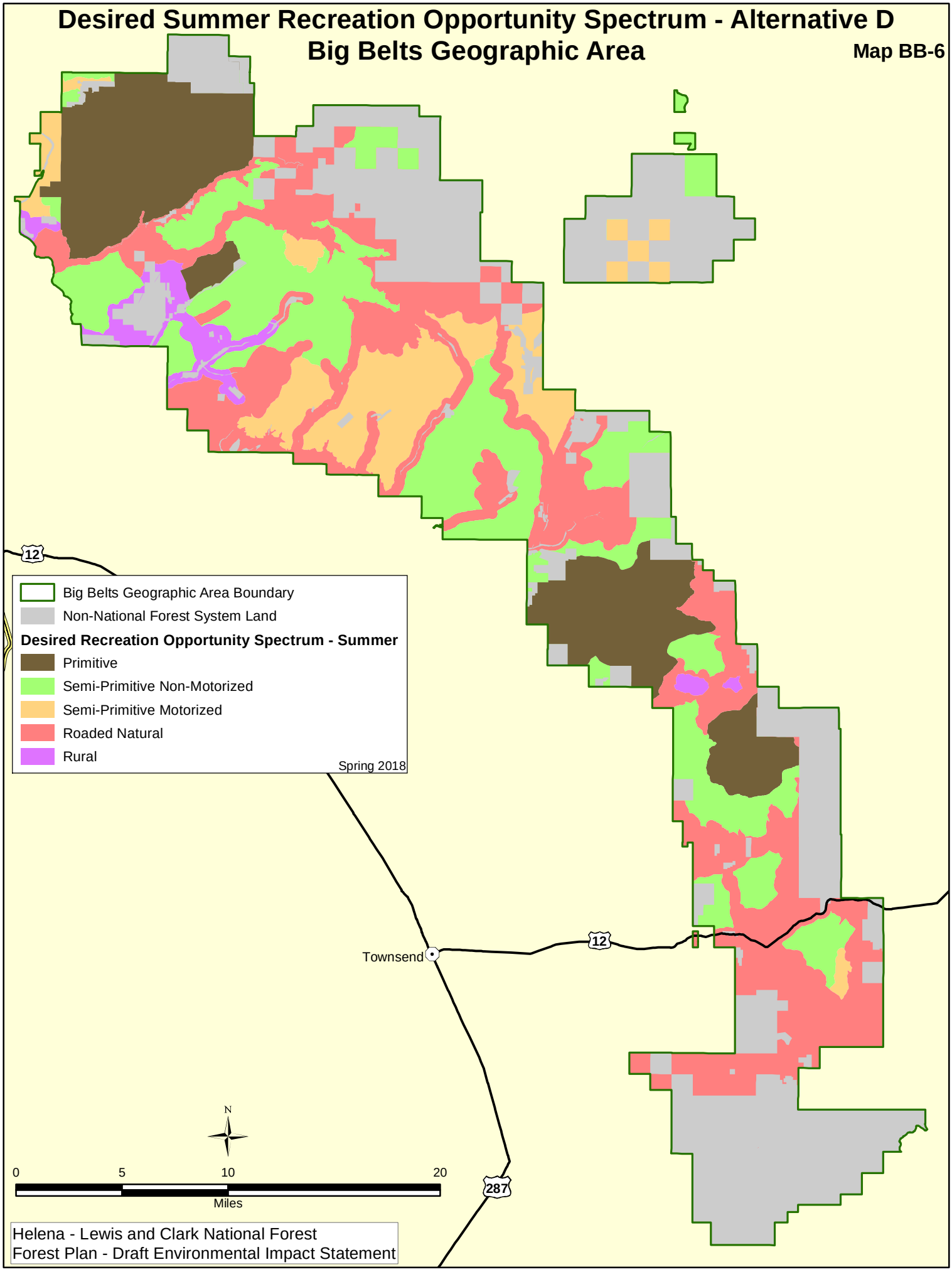
Map BB-5



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Big Belts Geographic Area

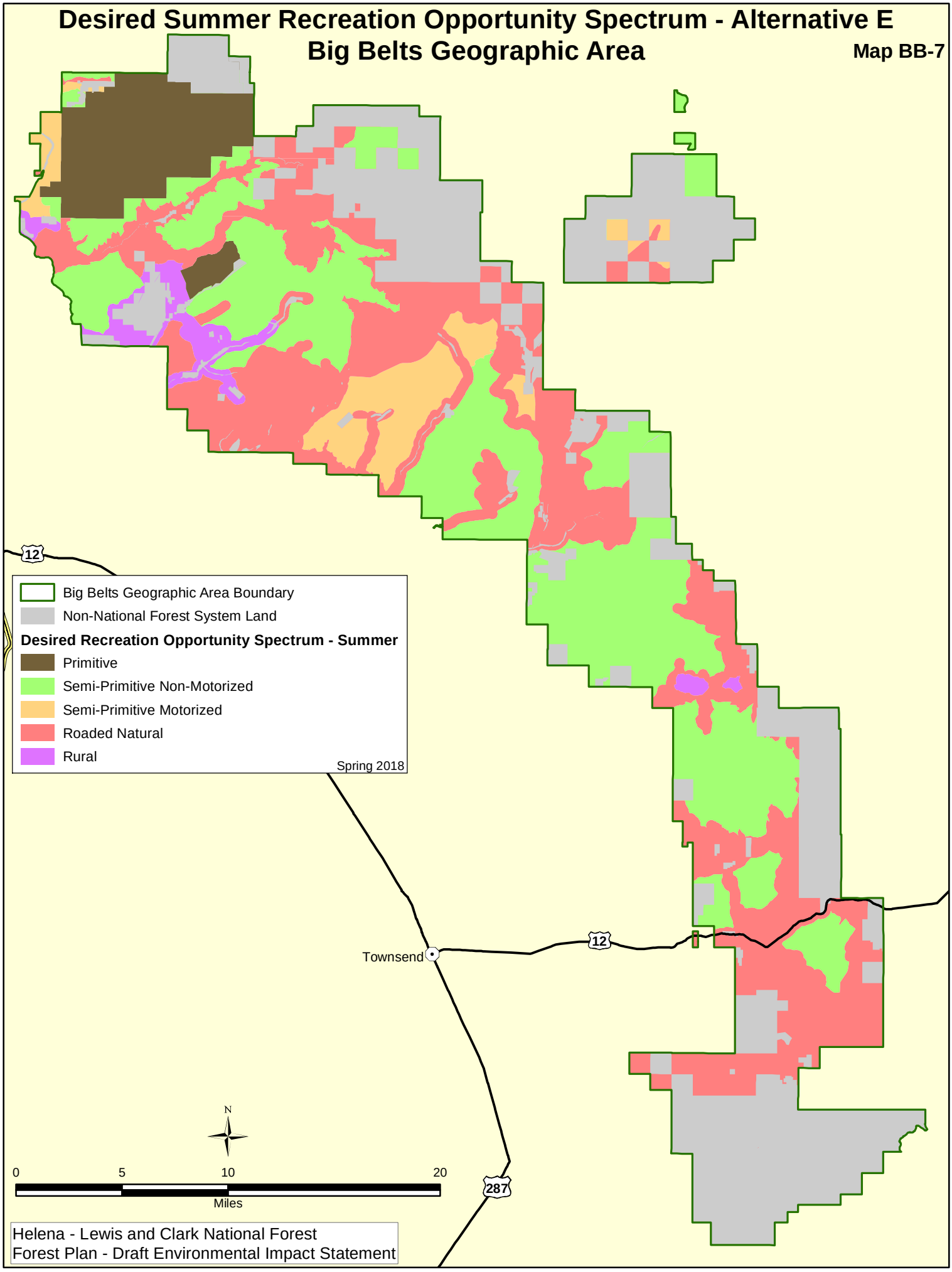
Map BB-6



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Desired Summer Recreation Opportunity Spectrum - Alternative E
Big Belts Geographic Area

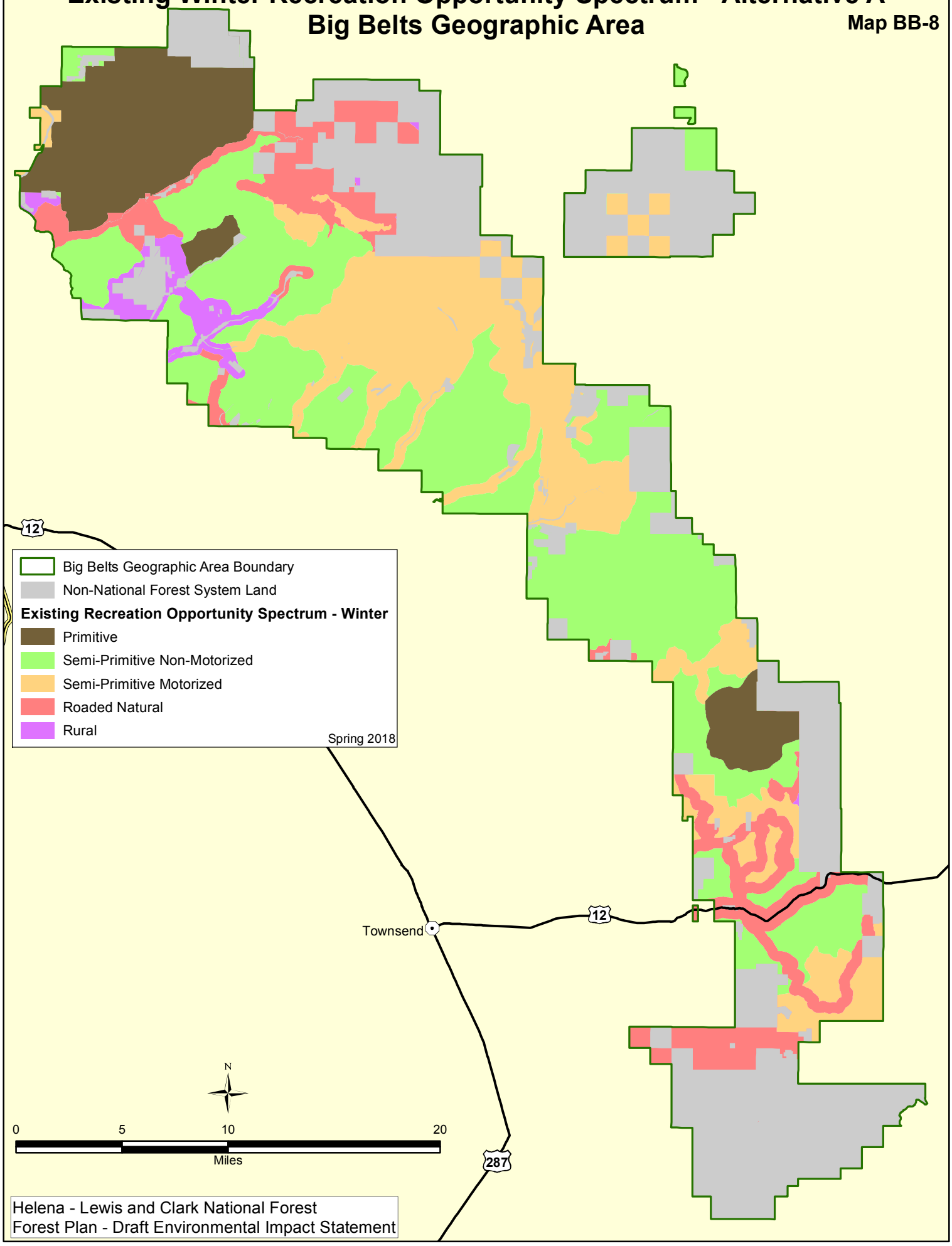
Map BB-7



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Big Belts Geographic Area

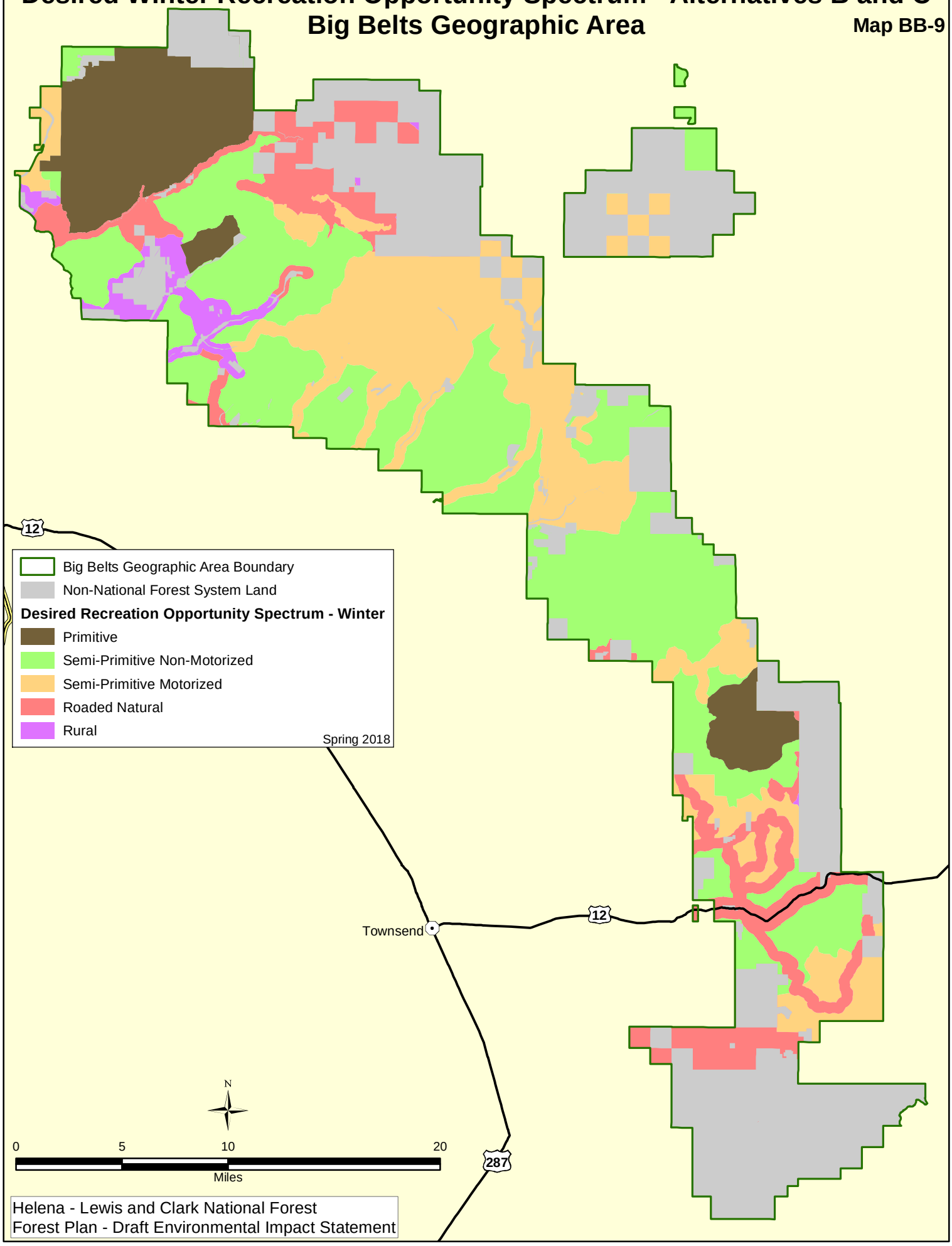
Map BB-8



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Desired Winter Recreation Opportunity Spectrum - Alternatives B and C
Big Belts Geographic Area

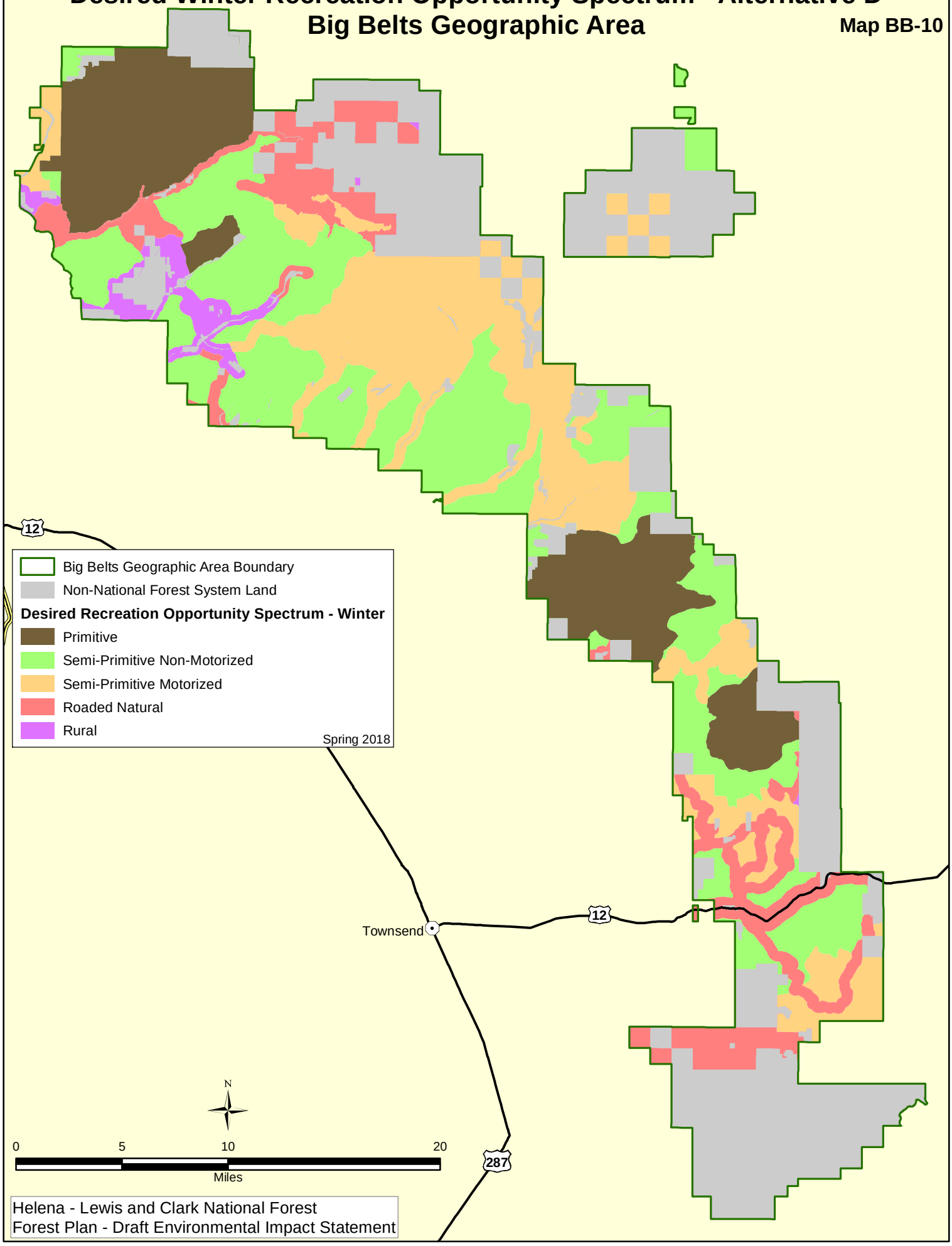
Map BB-9



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Desired Winter Recreation Opportunity Spectrum - Alternative D
Big Belts Geographic Area

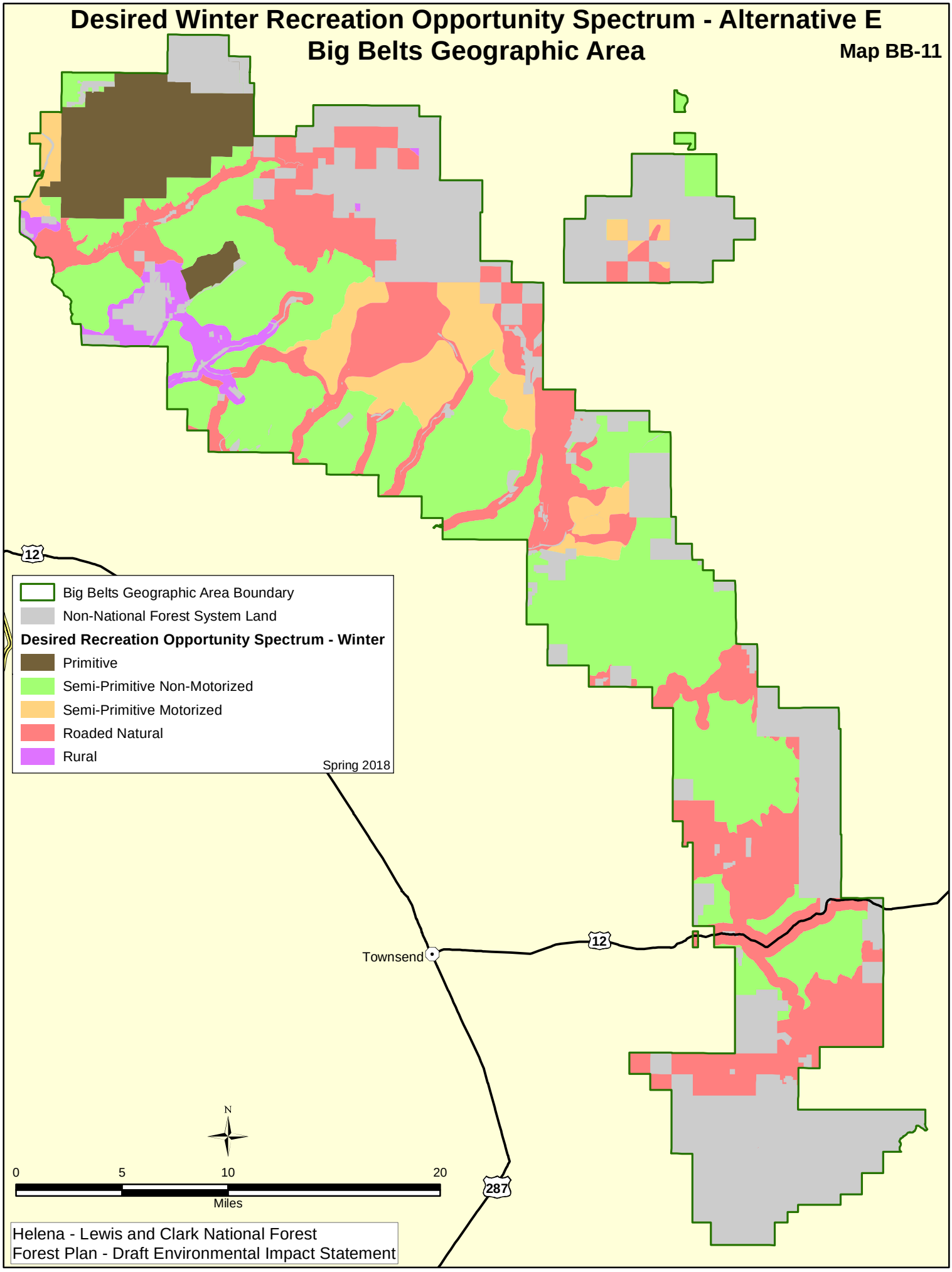
Map BB-10



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Desired Winter Recreation Opportunity Spectrum - Alternative E
Big Belts Geographic Area

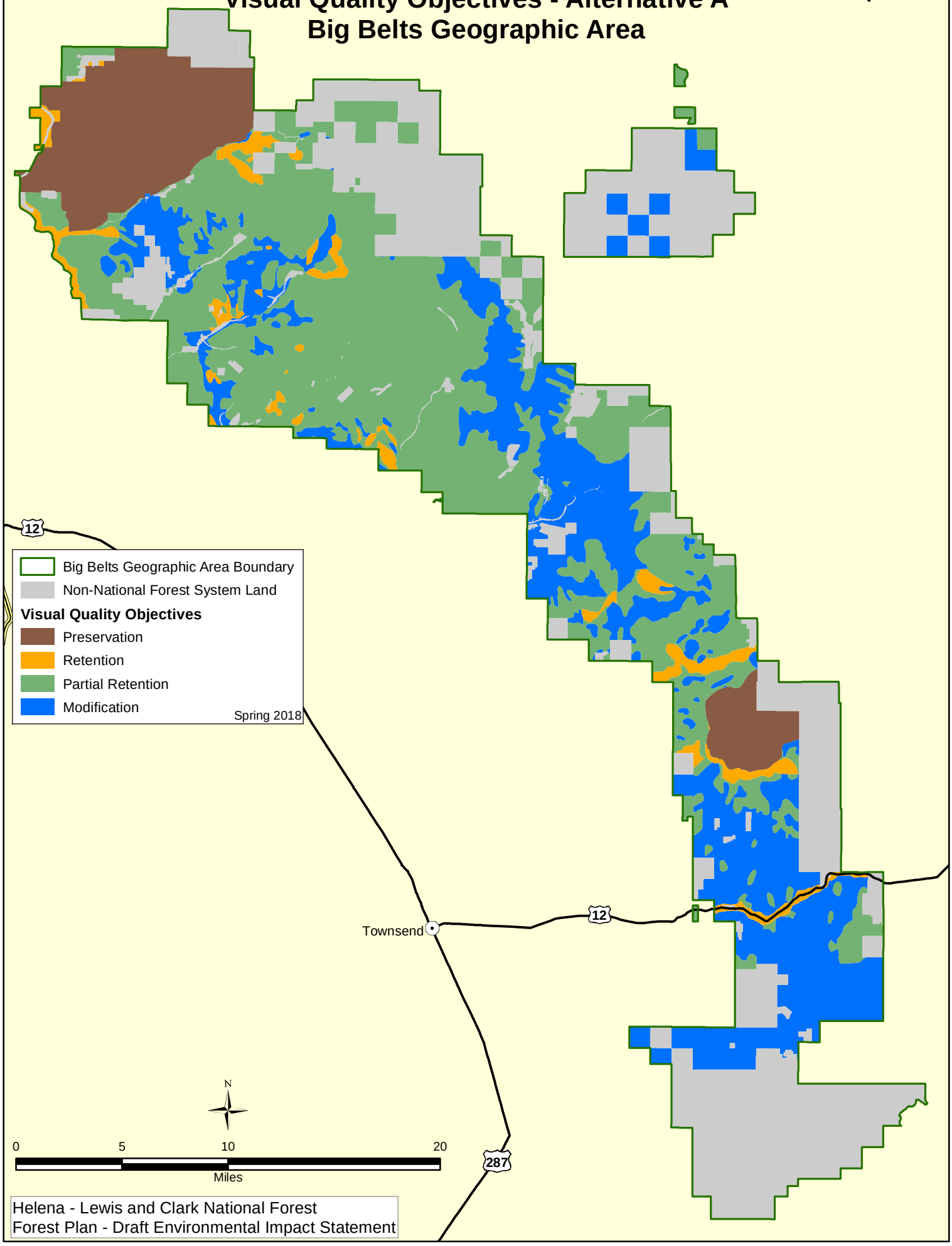
Map BB-11



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Visual Quality Objectives - Alternative A
Big Belts Geographic Area

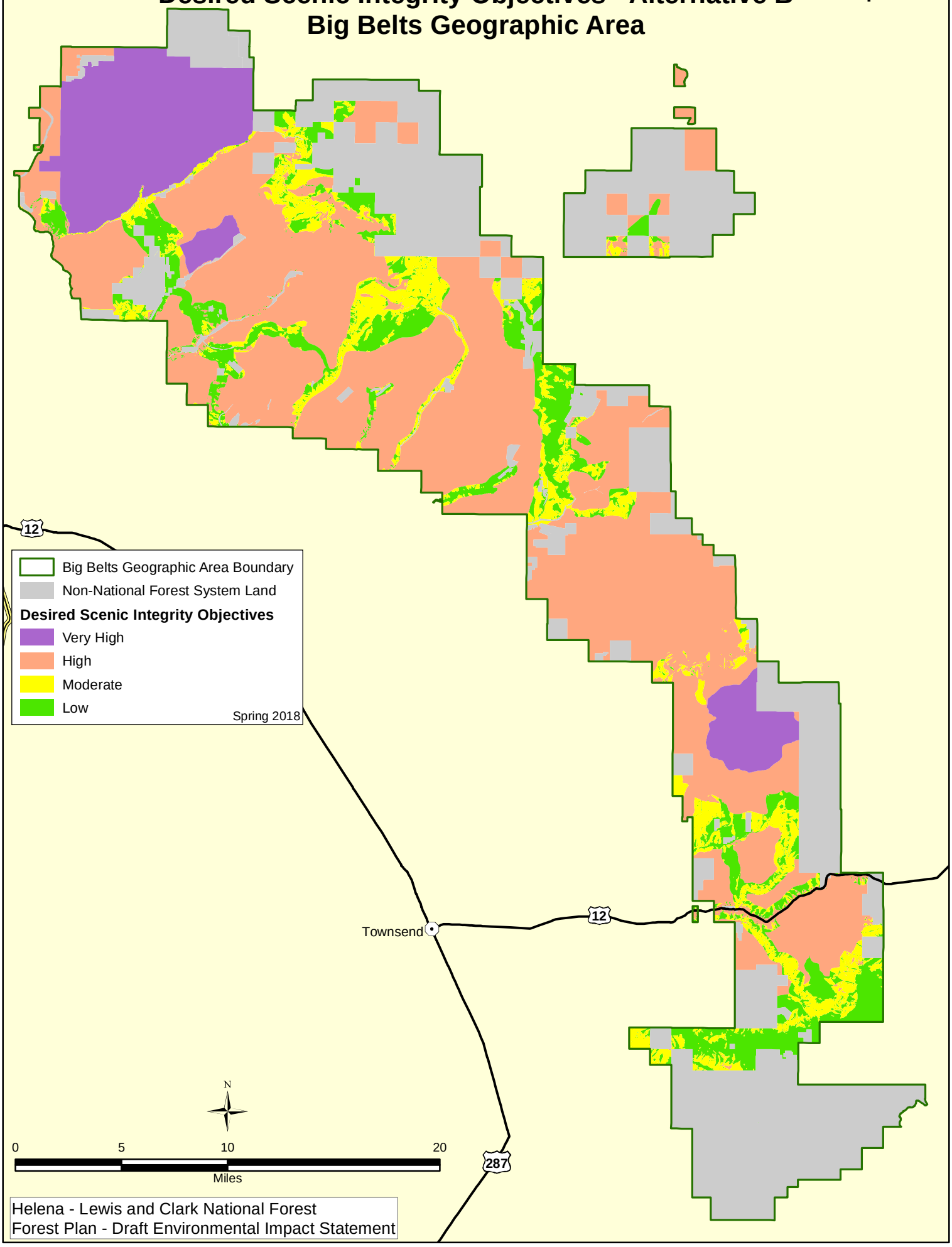
Map BB-12



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Desired Scenic Integrity Objectives - Alternative B
Big Belts Geographic Area

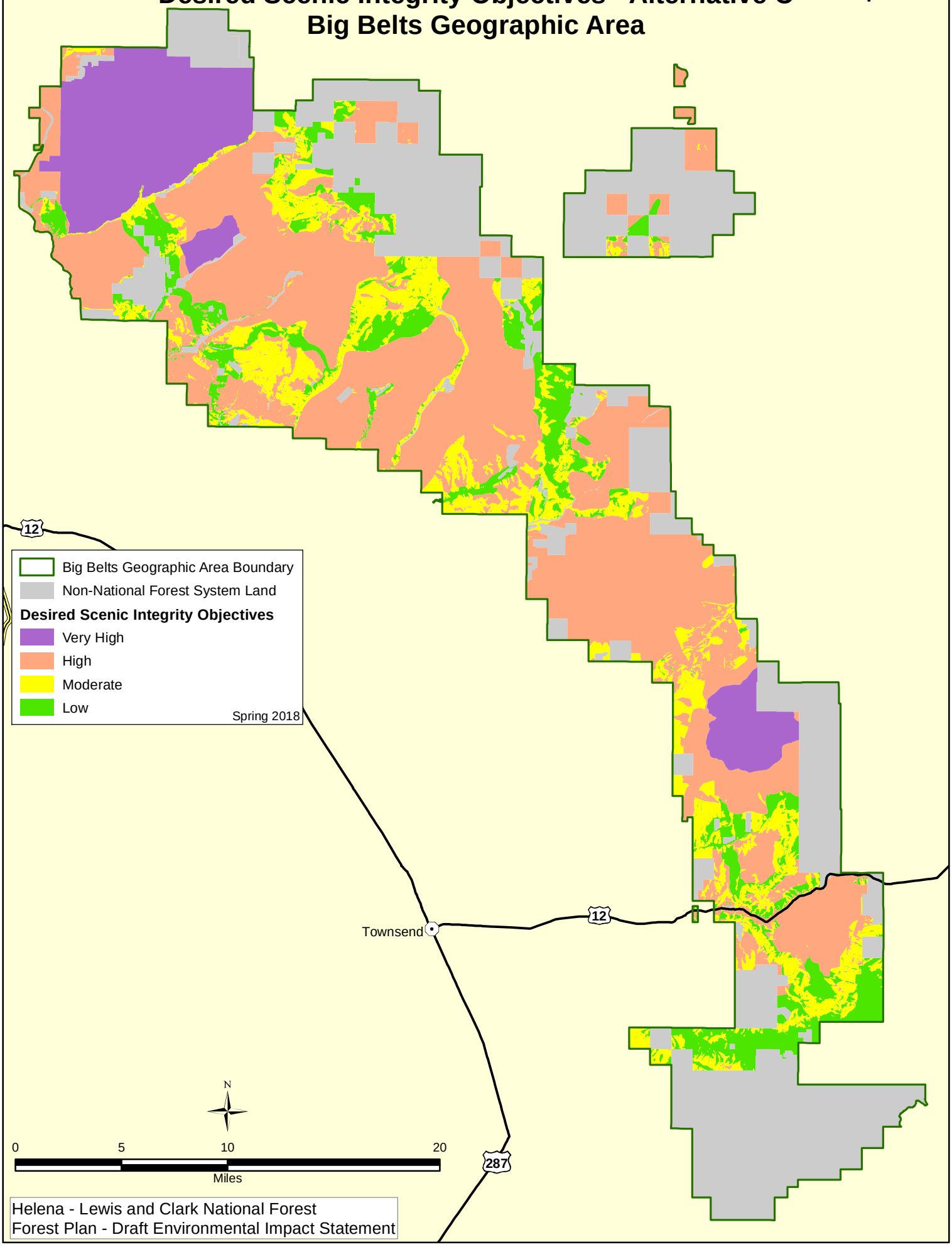
Map BB-13



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Desired Scenic Integrity Objectives - Alternative C
Big Belts Geographic Area

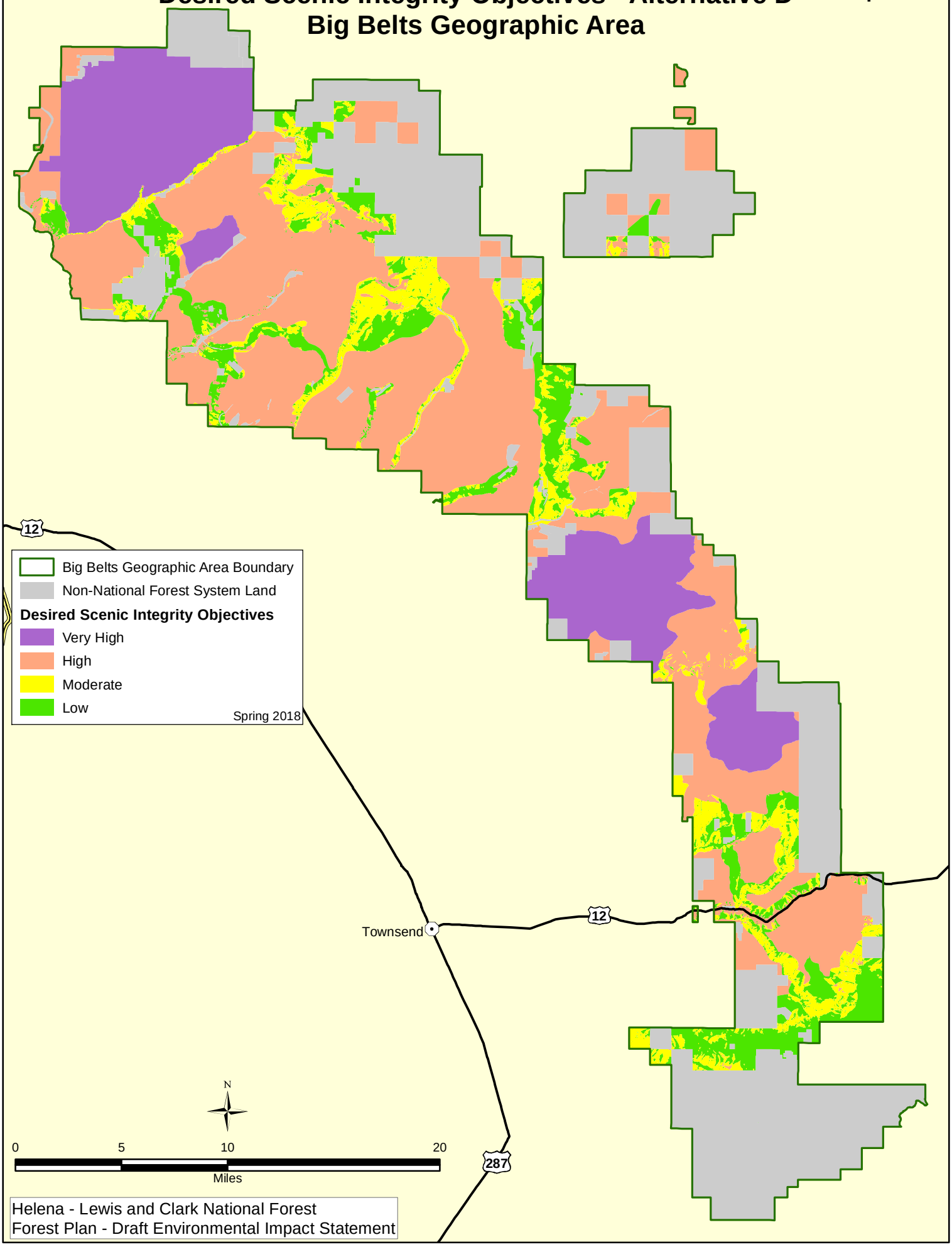
Map BB-14



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Desired Scenic Integrity Objectives - Alternative D
Big Belts Geographic Area

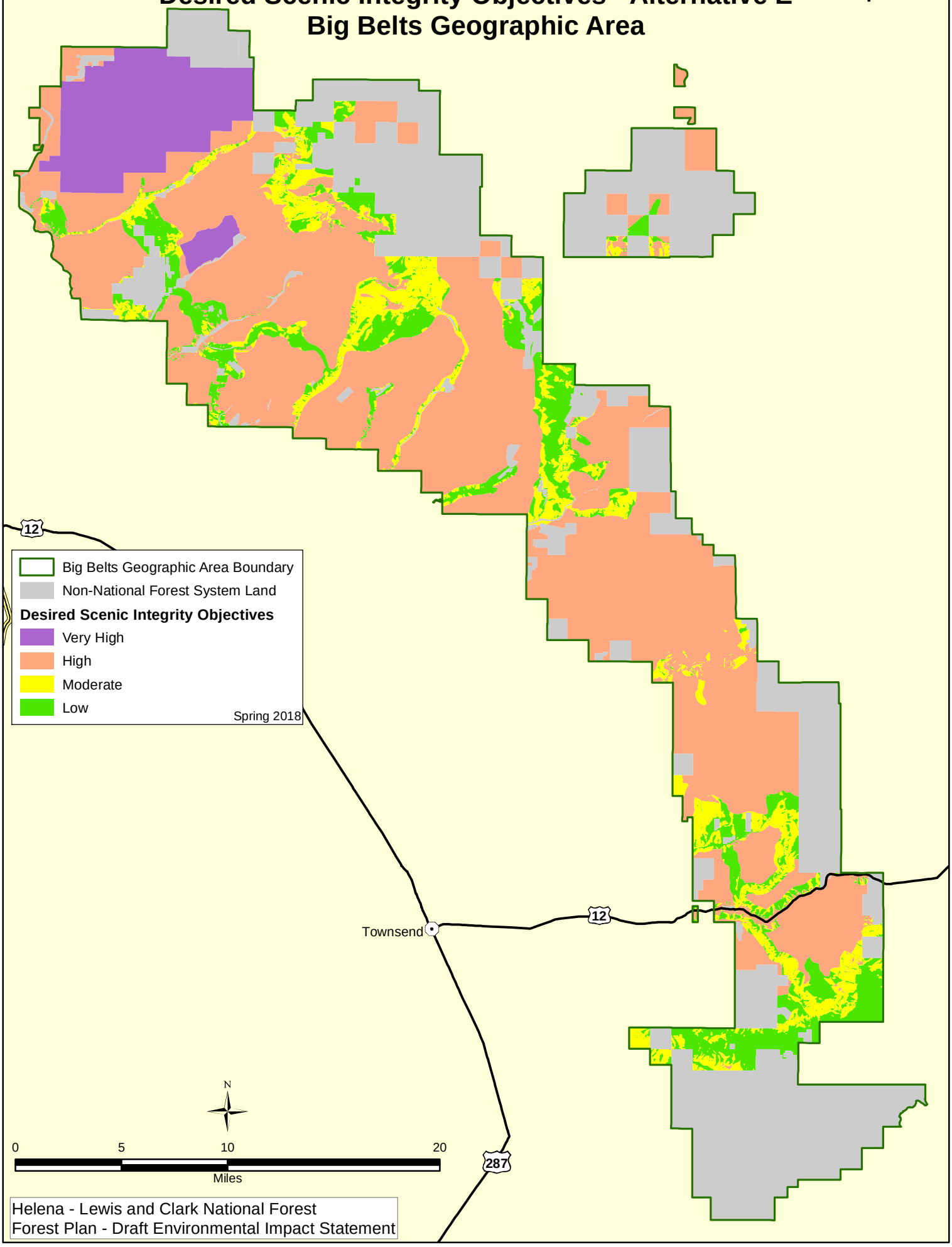
Map BB-15



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Desired Scenic Integrity Objectives - Alternative E
Big Belts Geographic Area

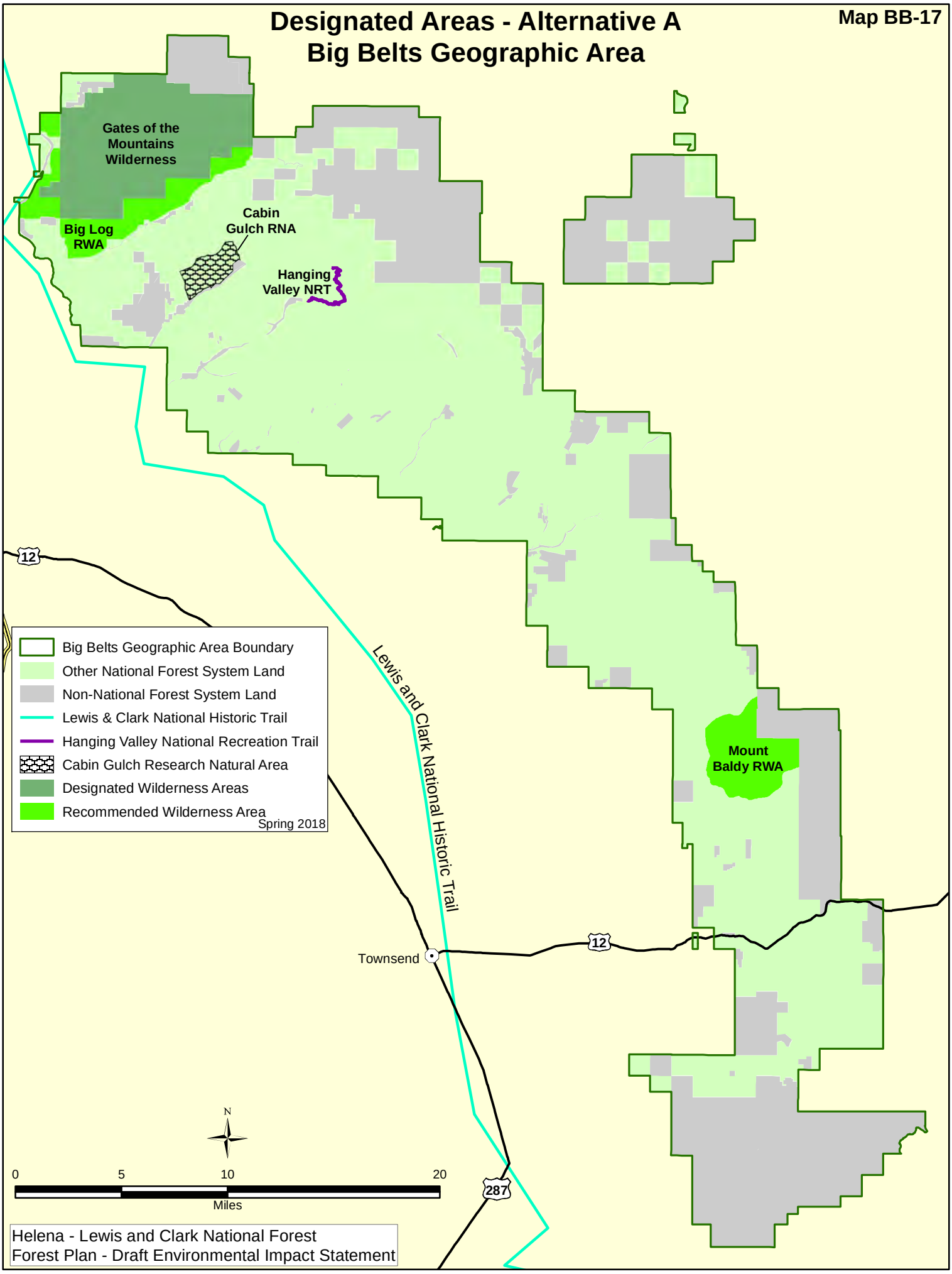
Map BB-16



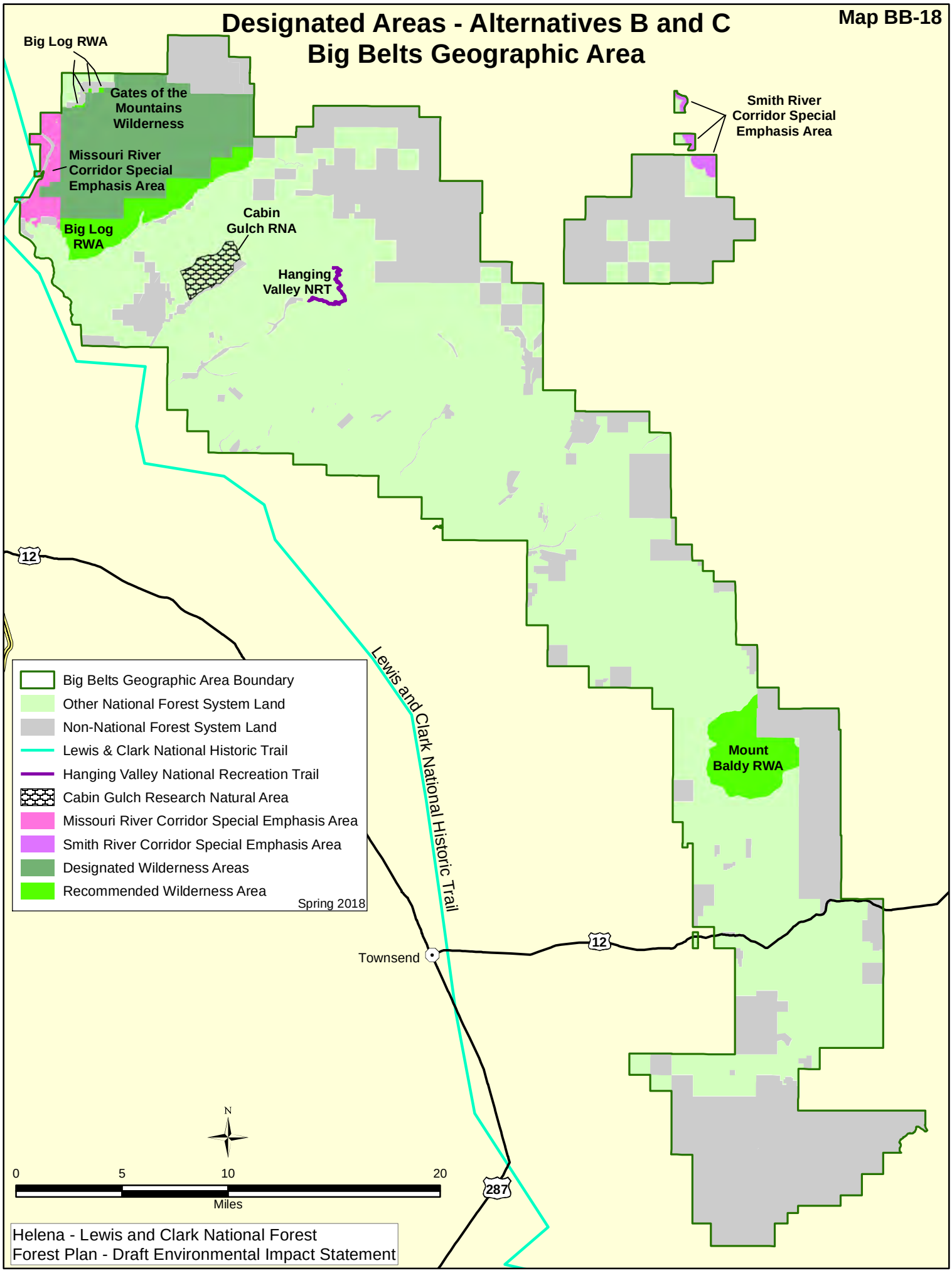
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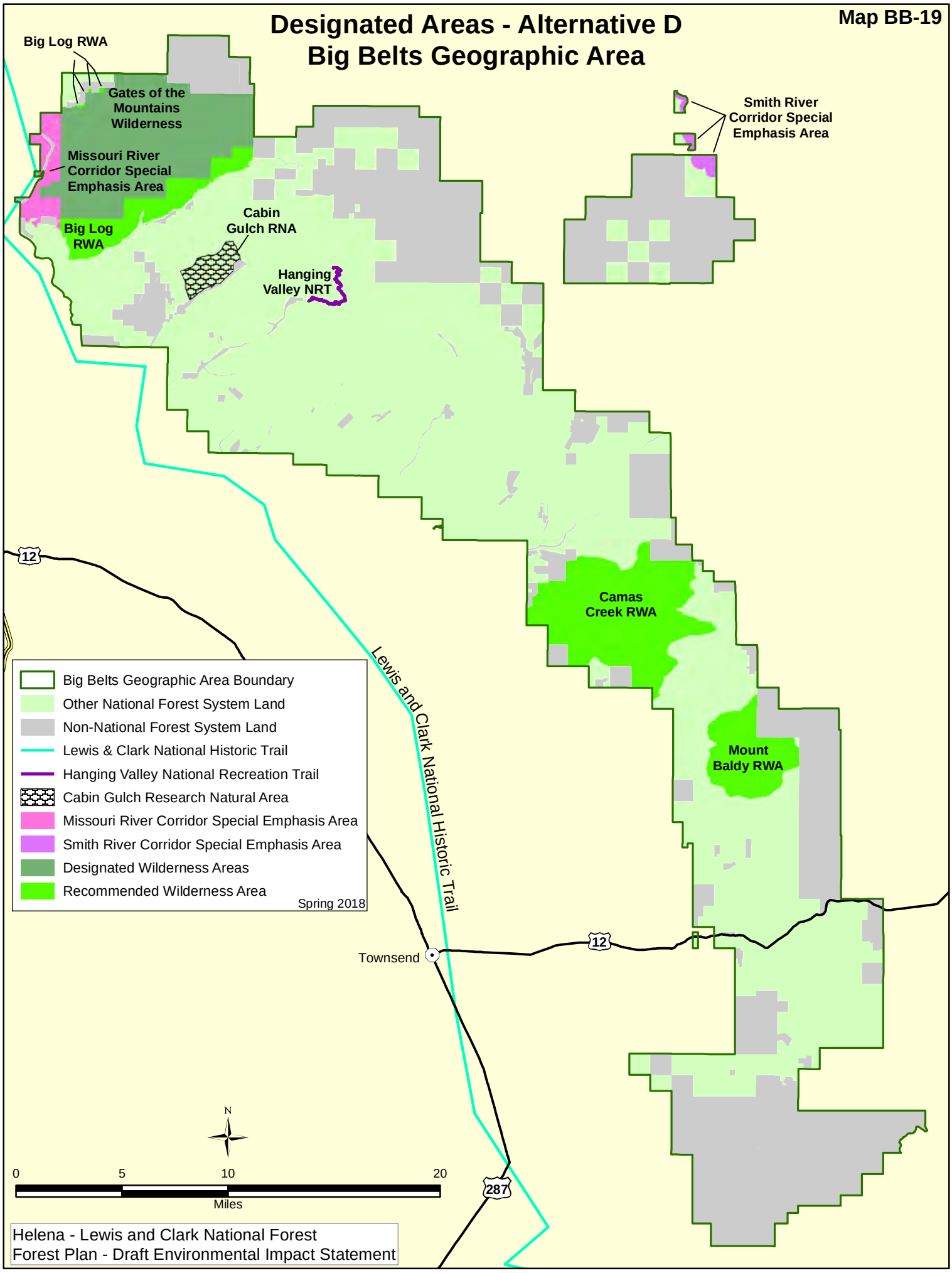
Designated Areas - Alternative A
Big Belts Geographic Area

Map BB-17



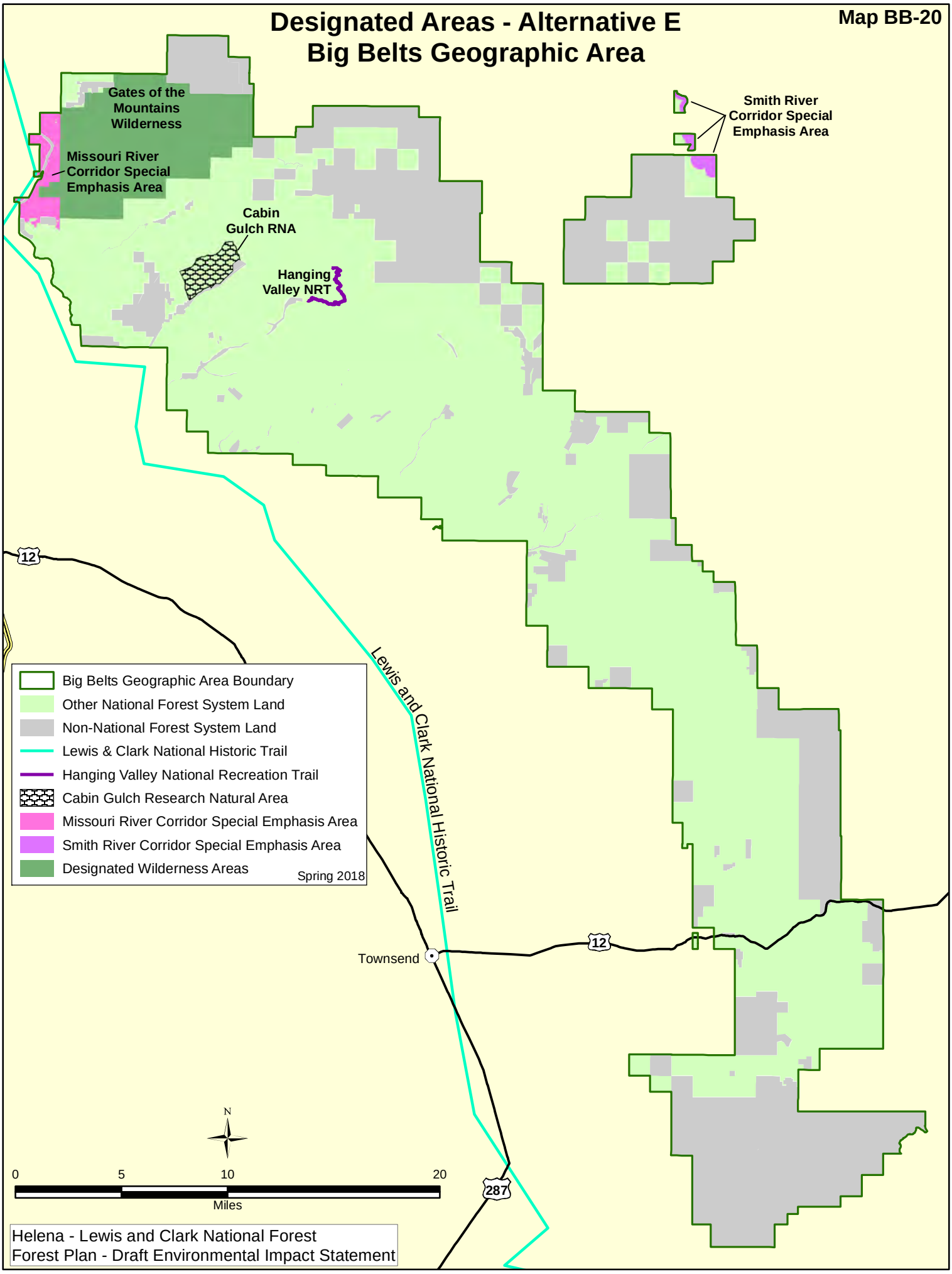
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Designated Areas - Alternatives B and C
Big Belts Geographic Area
Map BB-18
Big Log RWA
Gates of the Mountains Wilderness
Missouri River Corridor Special Emphasis Area
Big Log RWA
Cabin Gulch RNA
Hanging Valley NRT
Smith River Corridor Special Emphasis Area
Mount Baldy RWA
Lewis and Clark National Historic Trail
Townsend
12
12
287
Big Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Lewis & Clark National Historic Trail
Hanging Valley National Recreation Trail
Cabin Gulch Research Natural Area
Missouri River Corridor Special Emphasis Area
Smith River Corridor Special Emphasis Area
Designated Wilderness Areas
Recommended Wilderness Area
Spring 2018
N
0
5
10
20
Miles
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Designated Areas - Alternative D
Big Belts Geographic Area
Map BB-19
Big Log RWA
Gates of the Mountains Wilderness
Missouri River Corridor Special Emphasis Area
Big Log RWA
Cabin Gulch RNA
Hanging Valley NRT
Smith River Corridor Special Emphasis Area
Camas Creek RWA
Mount Baldy RWA
Lewis and Clark National Historic Trail
Townsend
12
12
287
Big Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Lewis & Clark National Historic Trail
Hanging Valley National Recreation Trail
Cabin Gulch Research Natural Area
Missouri River Corridor Special Emphasis Area
Smith River Corridor Special Emphasis Area
Designated Wilderness Areas
Recommended Wilderness Area
Spring 2018
N
0
5
10
20
Miles
Helena - Lewis and Clark National Forest
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Designated Areas - Alternative E
Big Belts Geographic Area

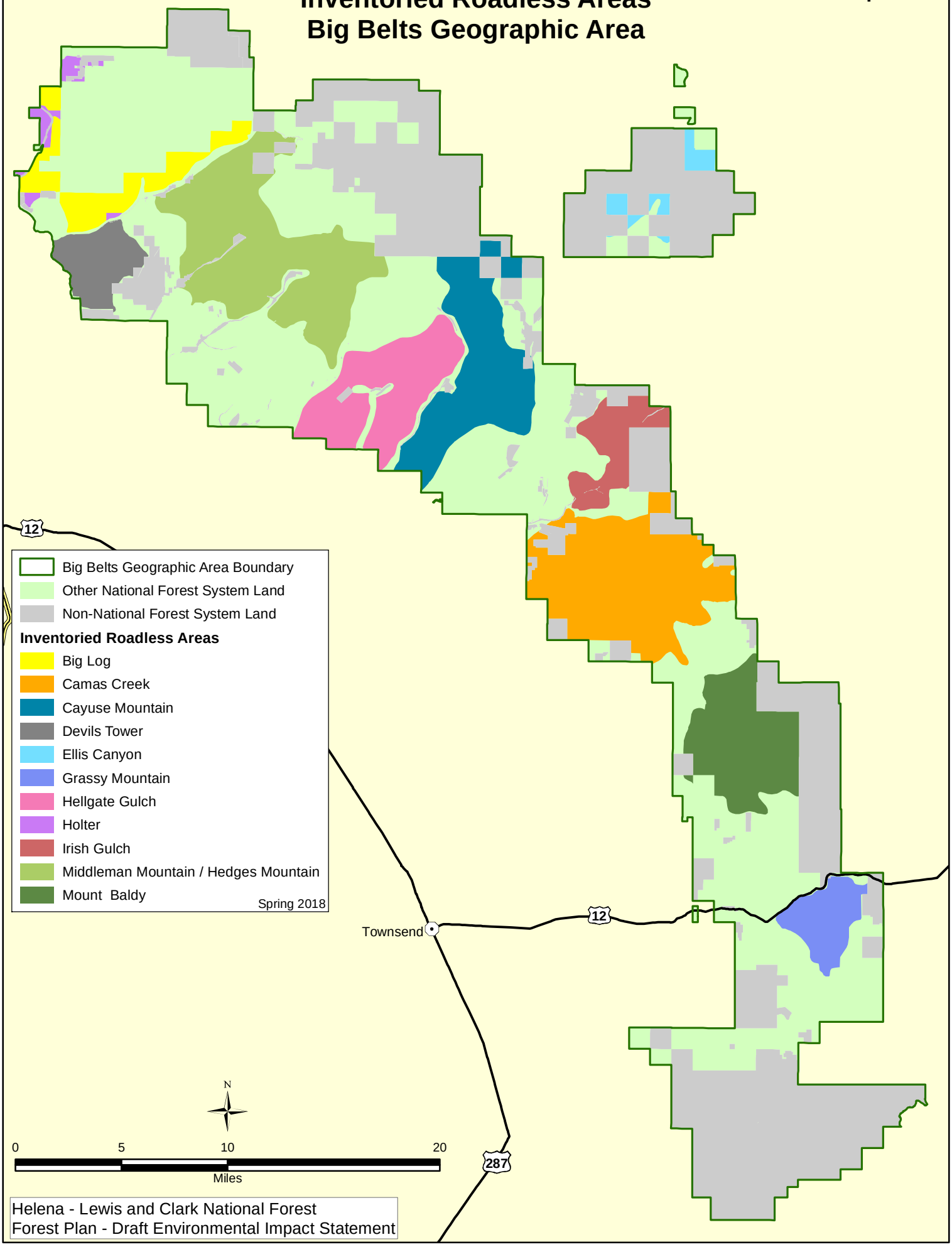
Map BB-20



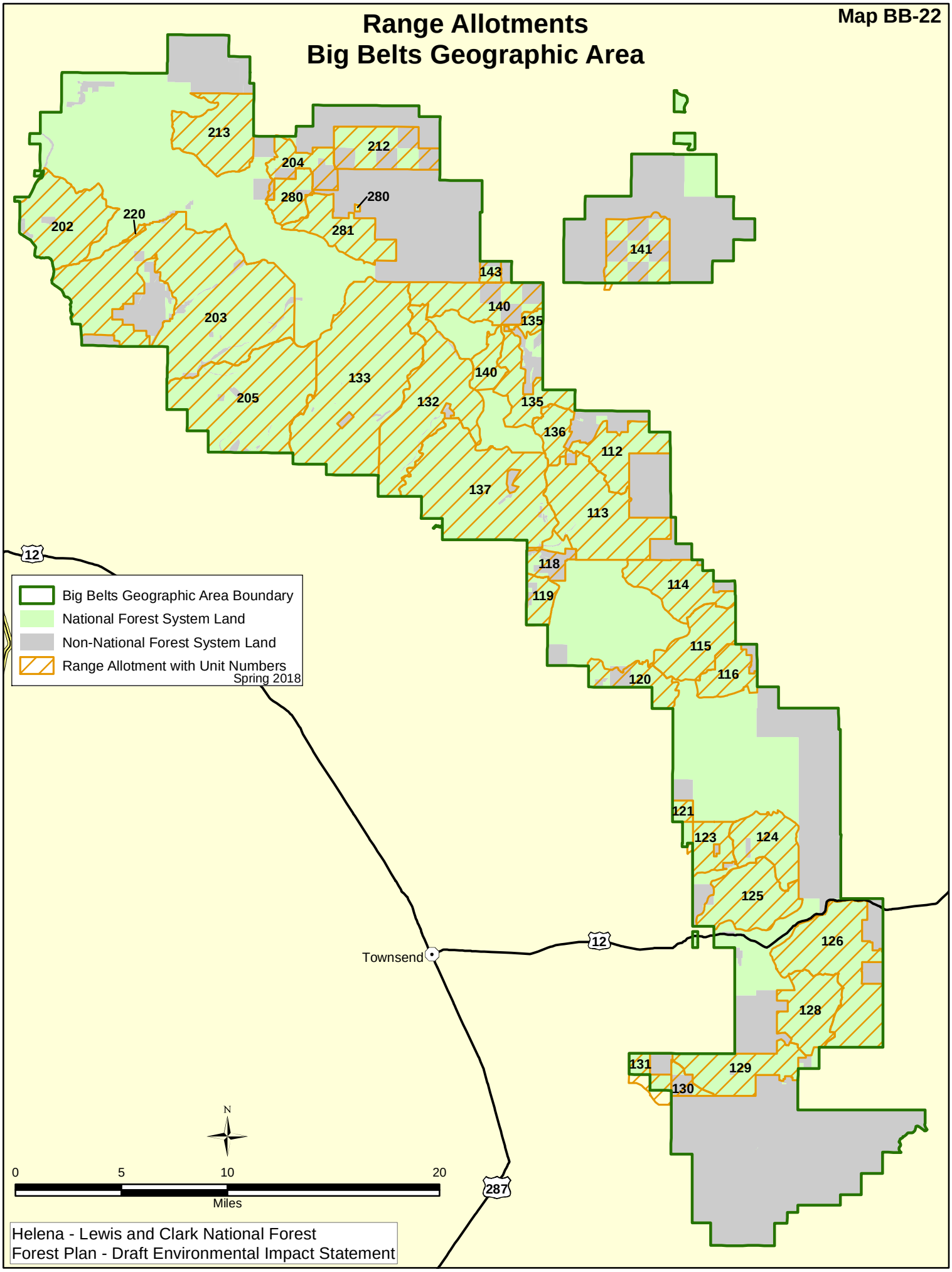
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Inventoried Roadless Areas
Big Belts Geographic Area

Map BB-21

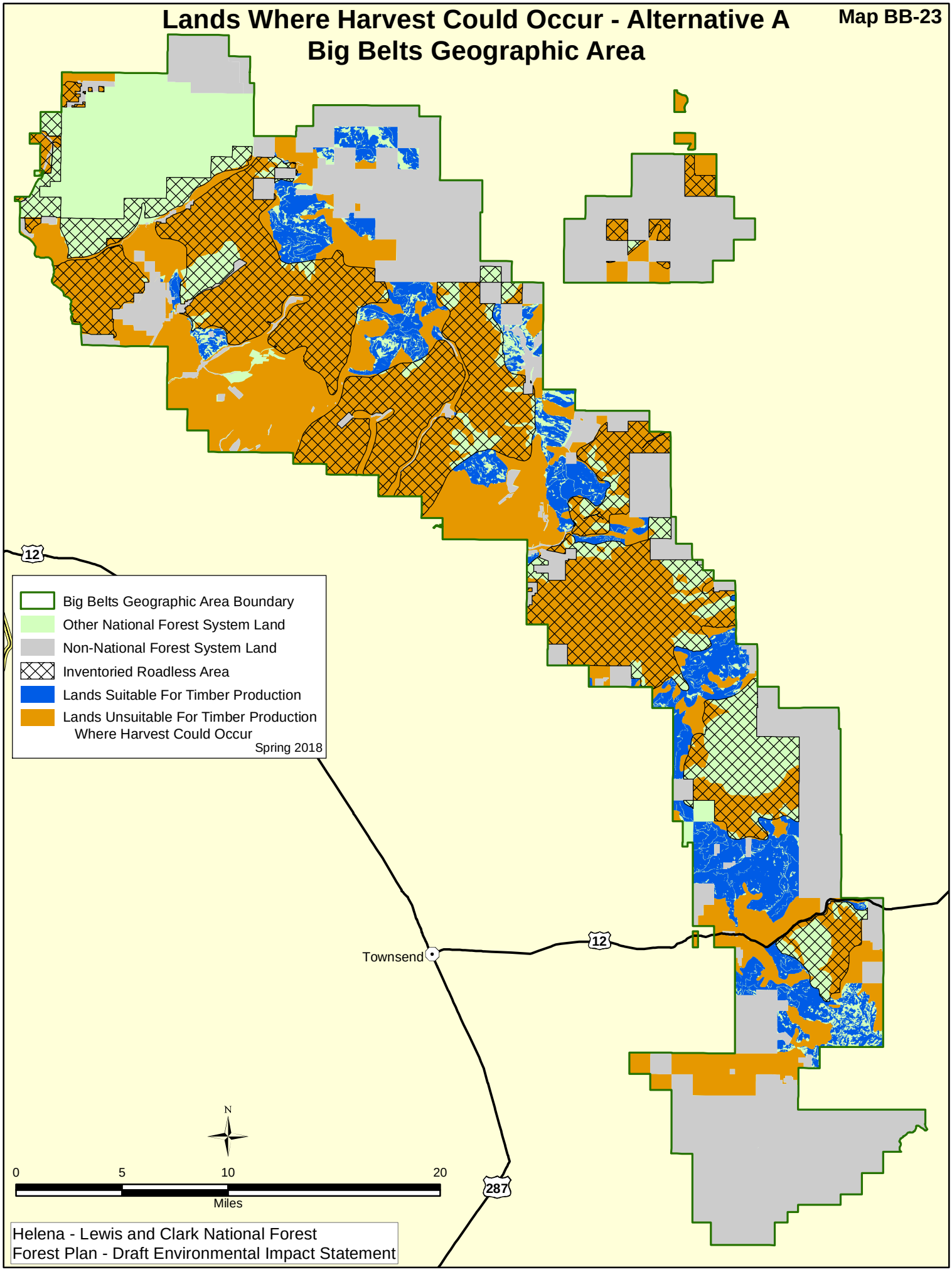


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Range Allotments
Big Belts Geographic Area
Map BB-22
213
212
204
280
280
281
202
220
141
143
140
135
203
133
140
205
132
135
136
112
137
113
118
114
119
115
120
116
121
123
124
125
126
128
131
129
130
12
12
287
Townsend
Big Belts Geographic Area Boundary
National Forest System Land
Non-National Forest System Land
Range Allotment with Unit Numbers
Spring 2018
N
0
5
10
20
Miles
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Lands Where Harvest Could Occur - Alternative A
Big Belts Geographic Area

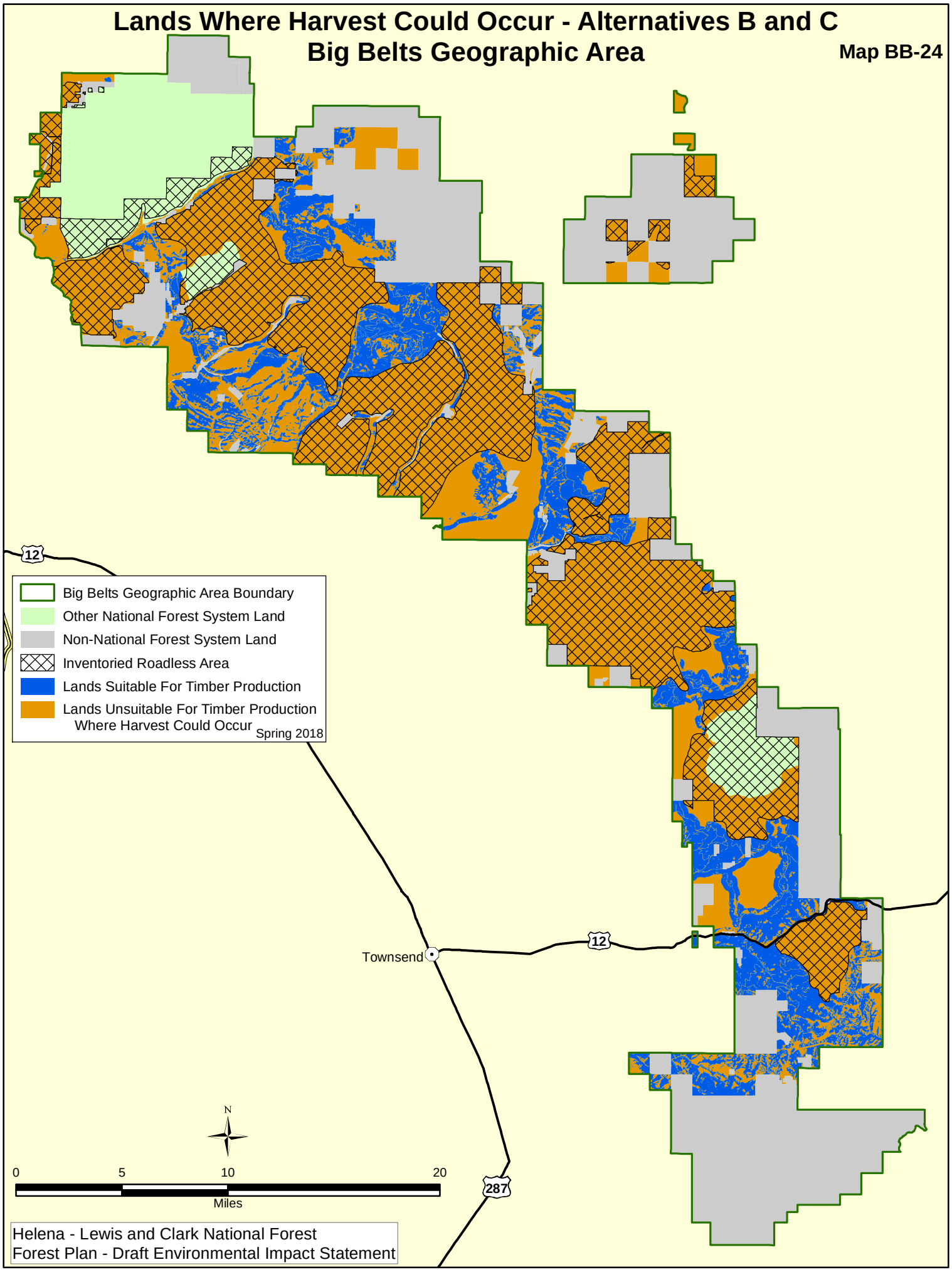
Map BB-23



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Lands Where Harvest Could Occur - Alternatives B and C
Big Belts Geographic Area

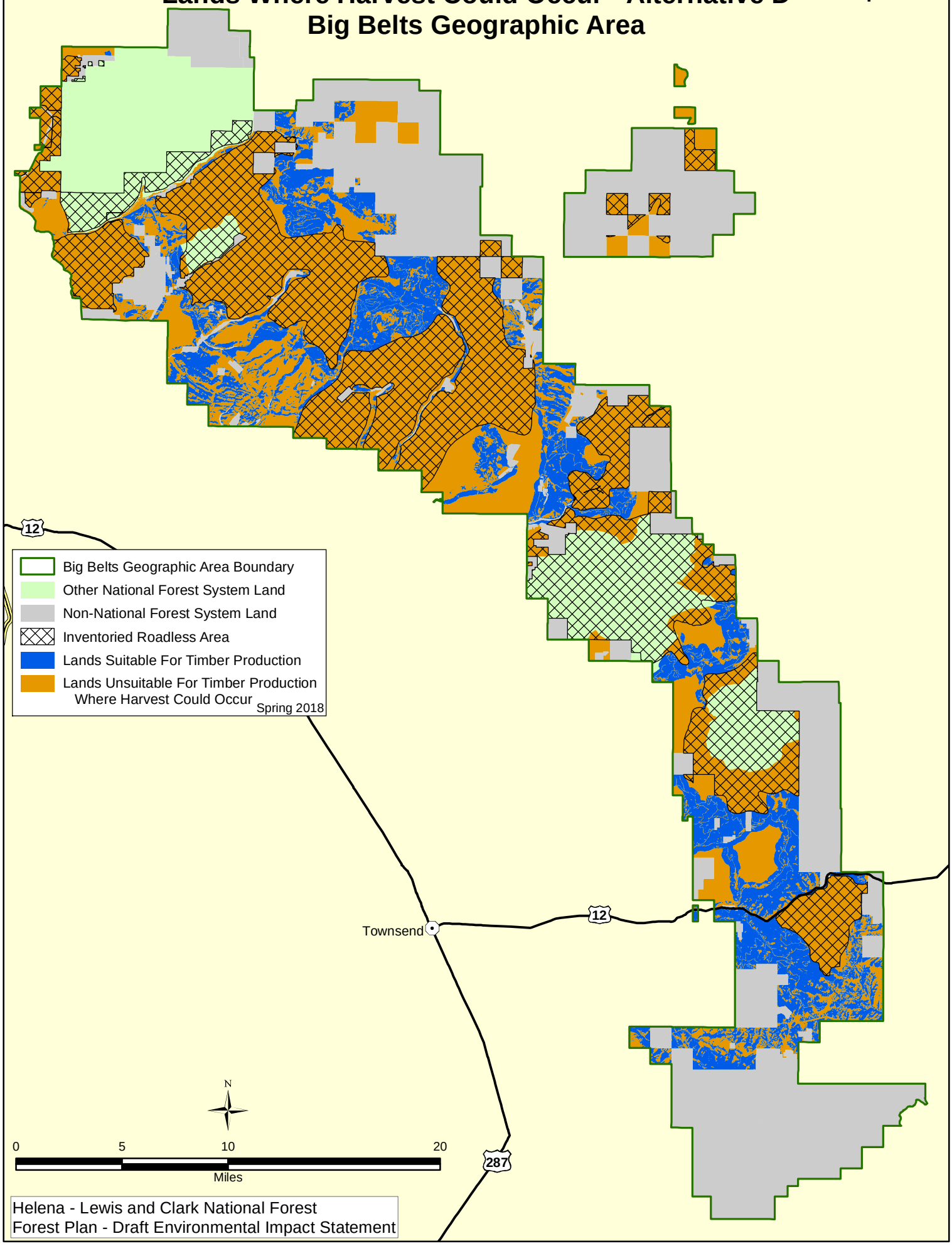
Map BB-24



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Lands Where Harvest Could Occur - Alternative D
Big Belts Geographic Area

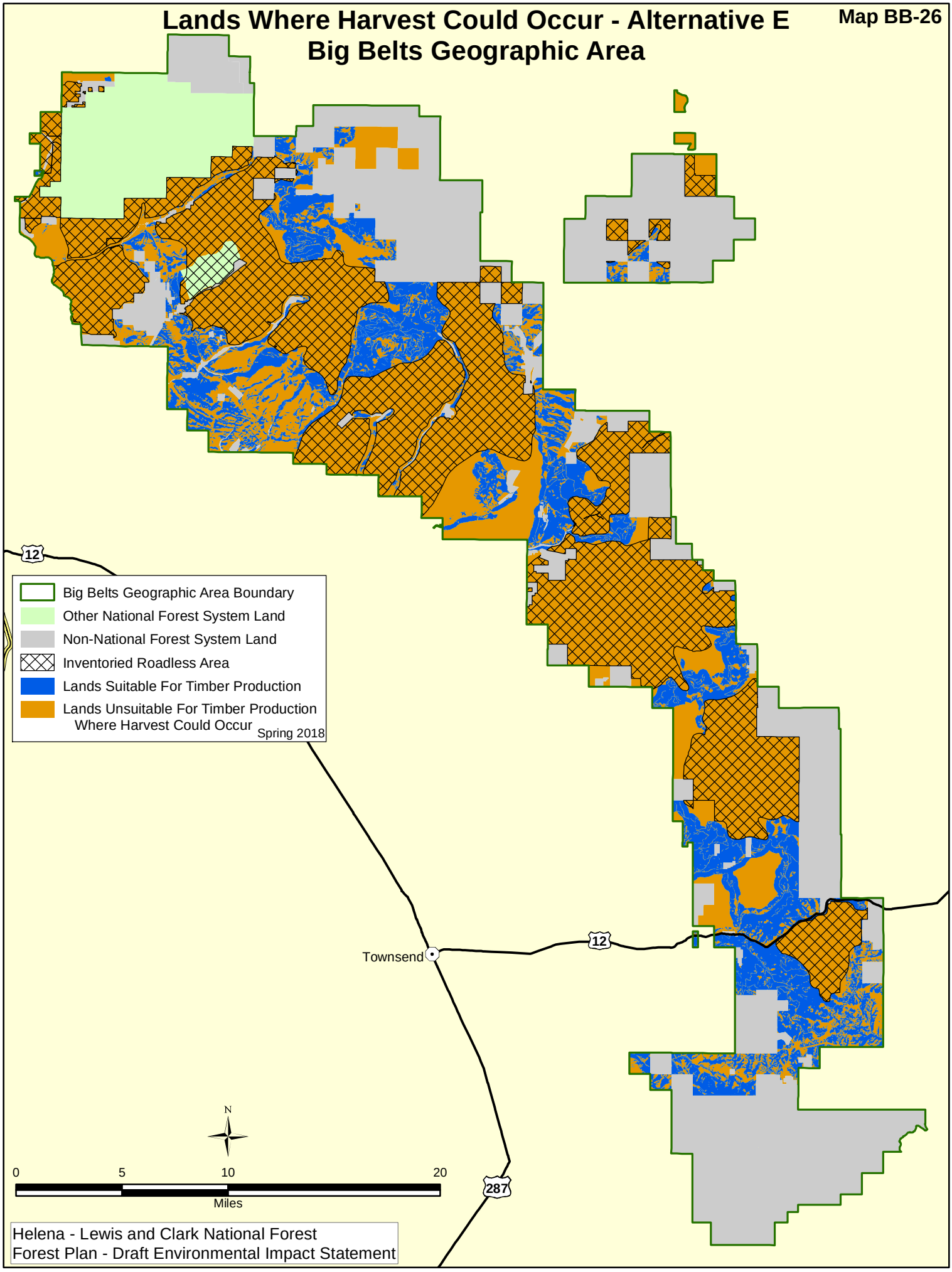
Map BB-25



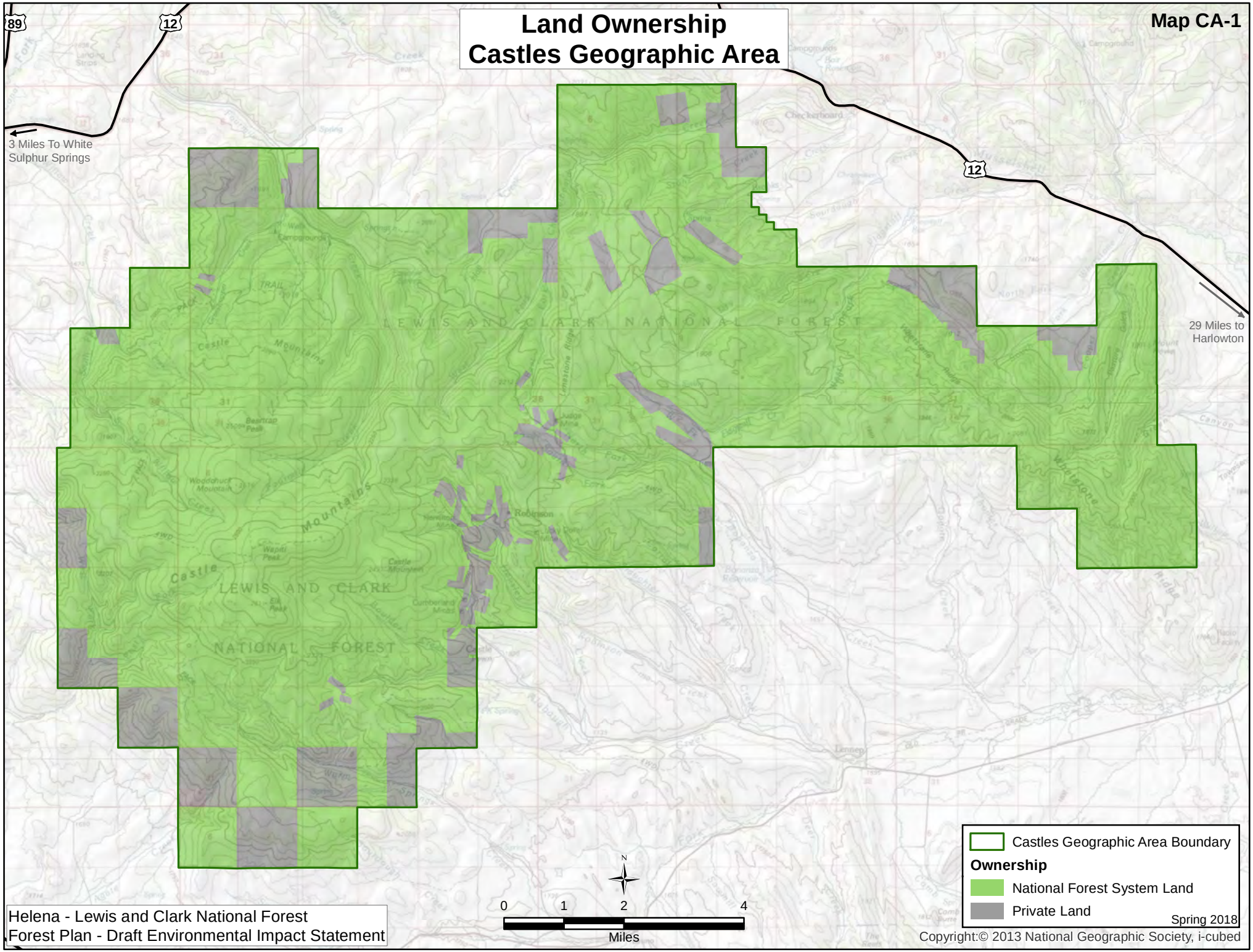
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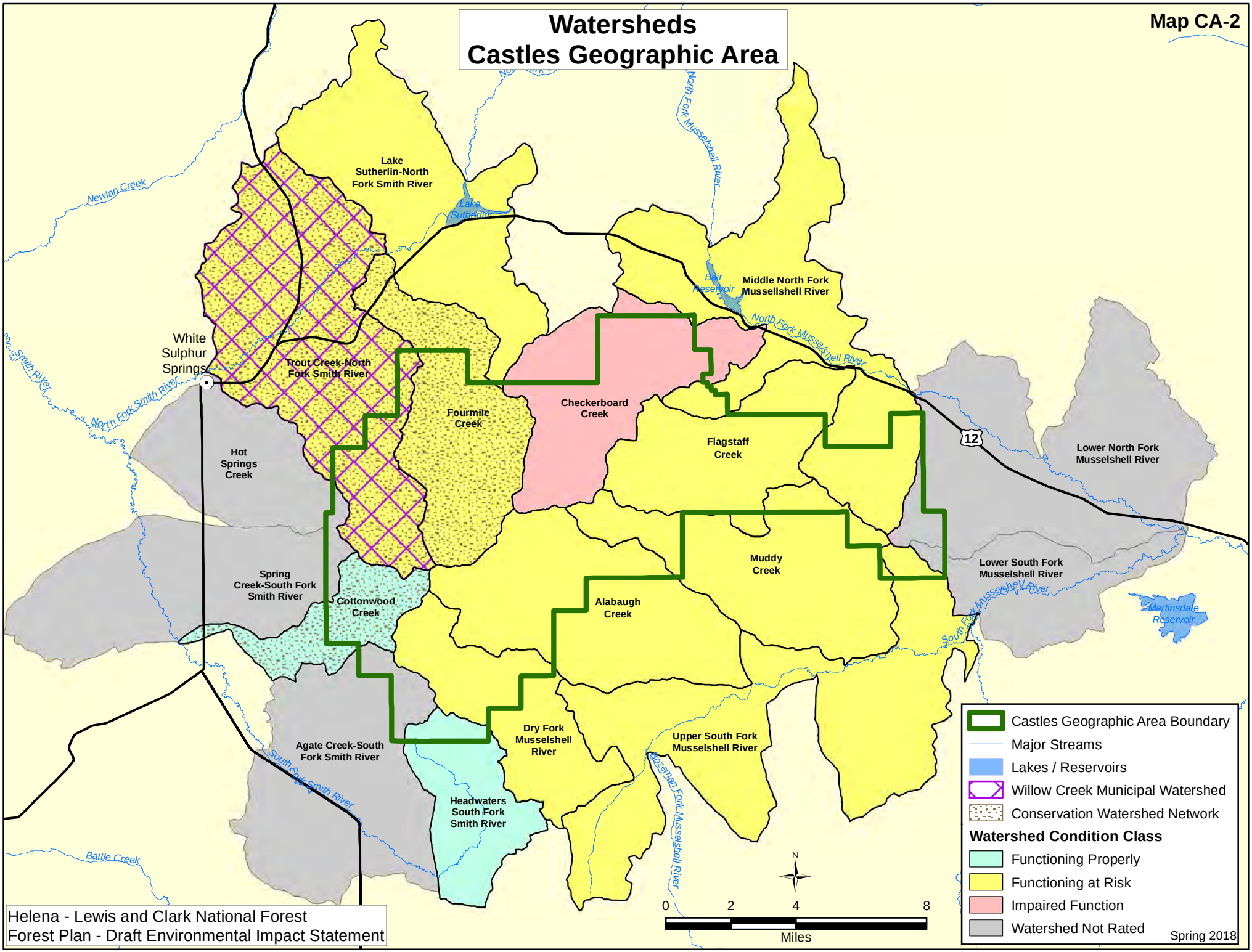
Lands Where Harvest Could Occur - Alternative E
Big Belts Geographic Area

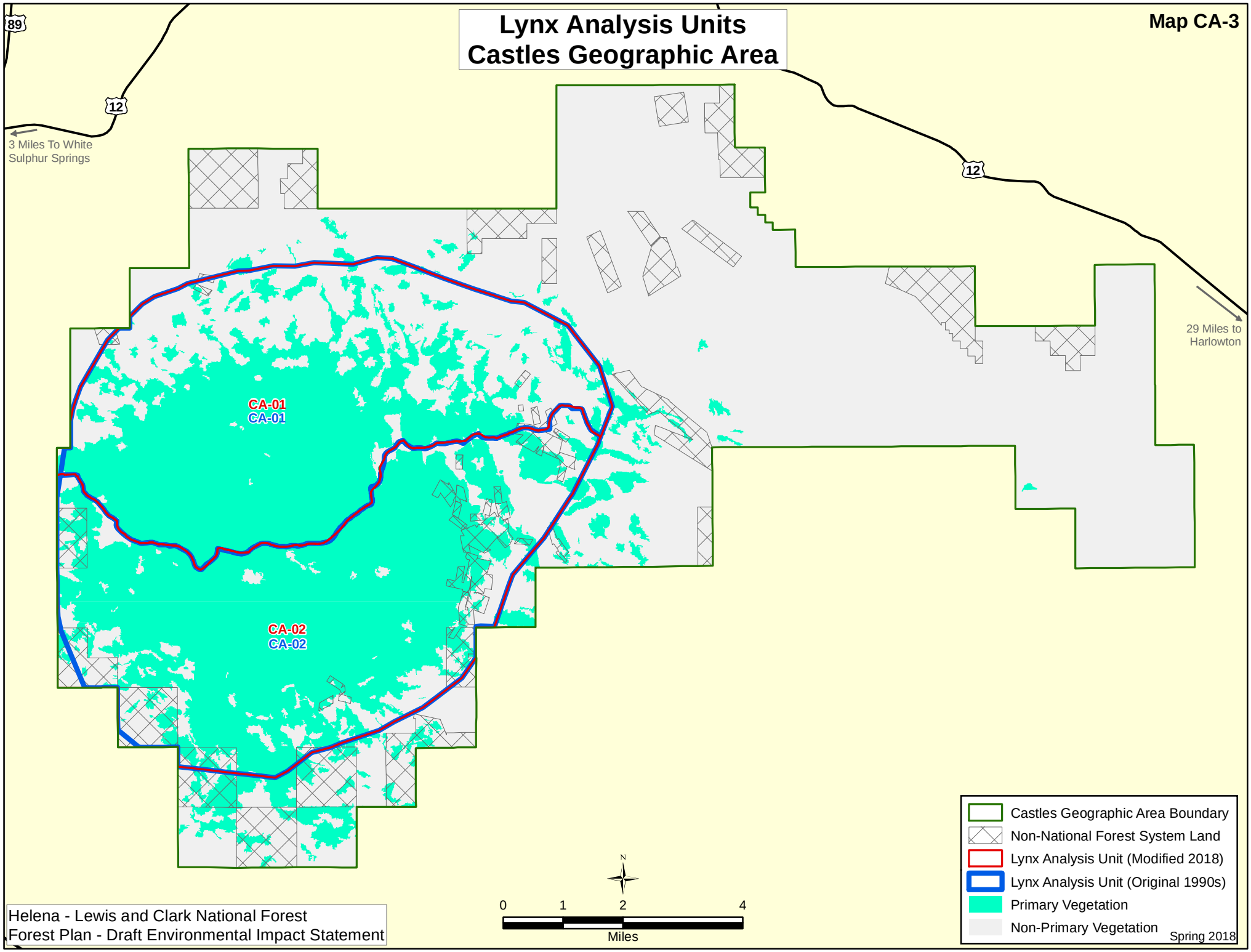
Map BB-26



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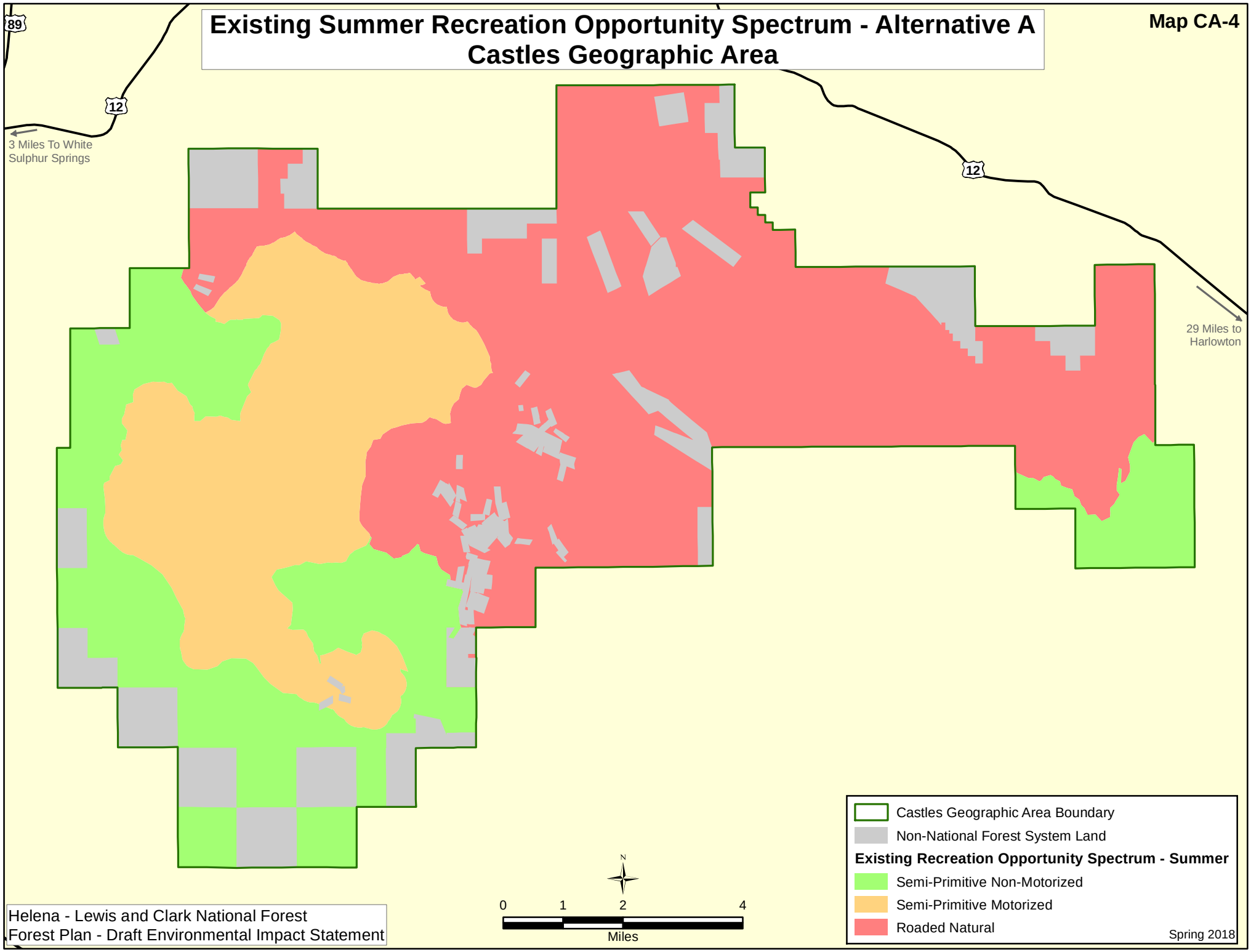

Land Ownership
Castles Geographic Area
Map CA-1
89
12
3 Miles To White Sulphur Springs
12
29 Miles to Harlowton
LEWIS AND CLARK NATIONAL FOREST
Castle Mountains
Castle Mountains
LEWIS AND CLARK NATIONAL FOREST
Robinson
Castles Geographic Area Boundary
Ownership
National Forest System Land
Private Land
Spring 2018
N
0 1 2 4
Miles
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Watersheds
Castles Geographic Area
Map CA-2
Lake Sutherlin-North Fork Smith River
Newlan Creek
Lake Sutherlin
North Fork Musselshell River
Bair Reservoir
Middle North Fork Musselshell River
North Fork Musselshell River
White Sulphur Springs
Trout Creek-North Fork Smith River
South Fork Smith River
North Fork Smith River
Checkerboard Creek
Fourmile Creek
Flagstaff Creek
12
Lower North Fork Musselshell River
Hot Springs Creek
Muddy Creek
Lower South Fork Musselshell River
Spring Creek-South Fork Smith River
Cottonwood Creek
Alabaugh Creek
South Fork Musselshell River
Martinsdale Reservoir
Agate Creek-South Fork Smith River
South Fork Smith River
Dry Fork Musselshell River
Upper South Fork Musselshell River
Headwaters South Fork Smith River
Bozeman Fork Musselshell River
Battle Creek
N
0
2
4
8
Miles
Castles Geographic Area Boundary
Major Streams
Lakes / Reservoirs
Willow Creek Municipal Watershed
Conservation Watershed Network
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018
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Lynx Analysis Units
Castles Geographic Area
Map CA-3
89
12
3 Miles To White
Sulphur Springs
12
29 Miles to
Harlowton
CA-01
CA-01
CA-02
CA-02
Castles Geographic Area Boundary
Non-National Forest System Land
Lynx Analysis Unit (Modified 2018)
Lynx Analysis Unit (Original 1990s)
Primary Vegetation
Non-Primary Vegetation
Spring 2018
N
0
1
2
4
Miles
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Existing Summer Recreation Opportunity Spectrum - Alternative A
Castles Geographic Area

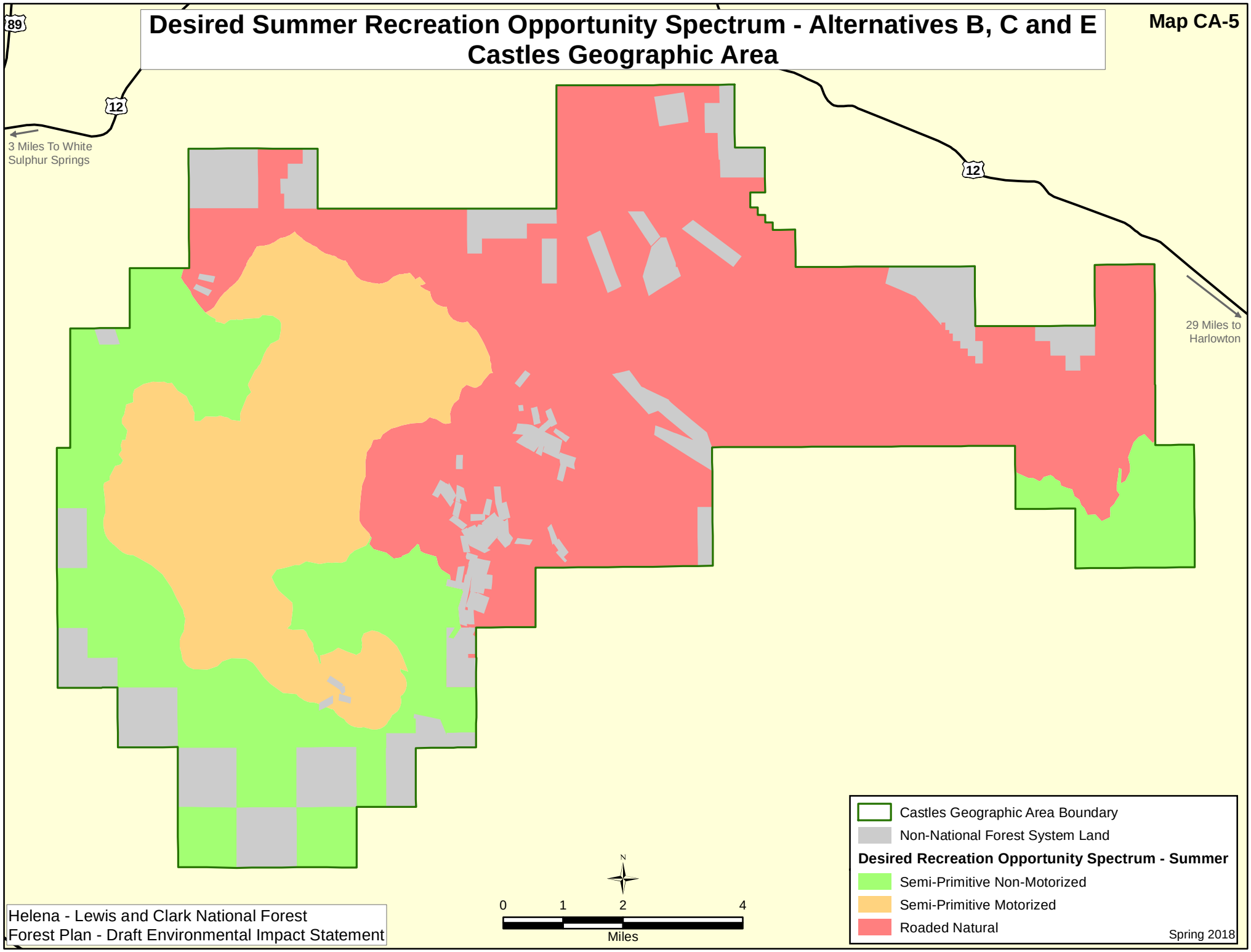
Map CA-4



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Desired Summer Recreation Opportunity Spectrum - Alternatives B, C and E
Castles Geographic Area

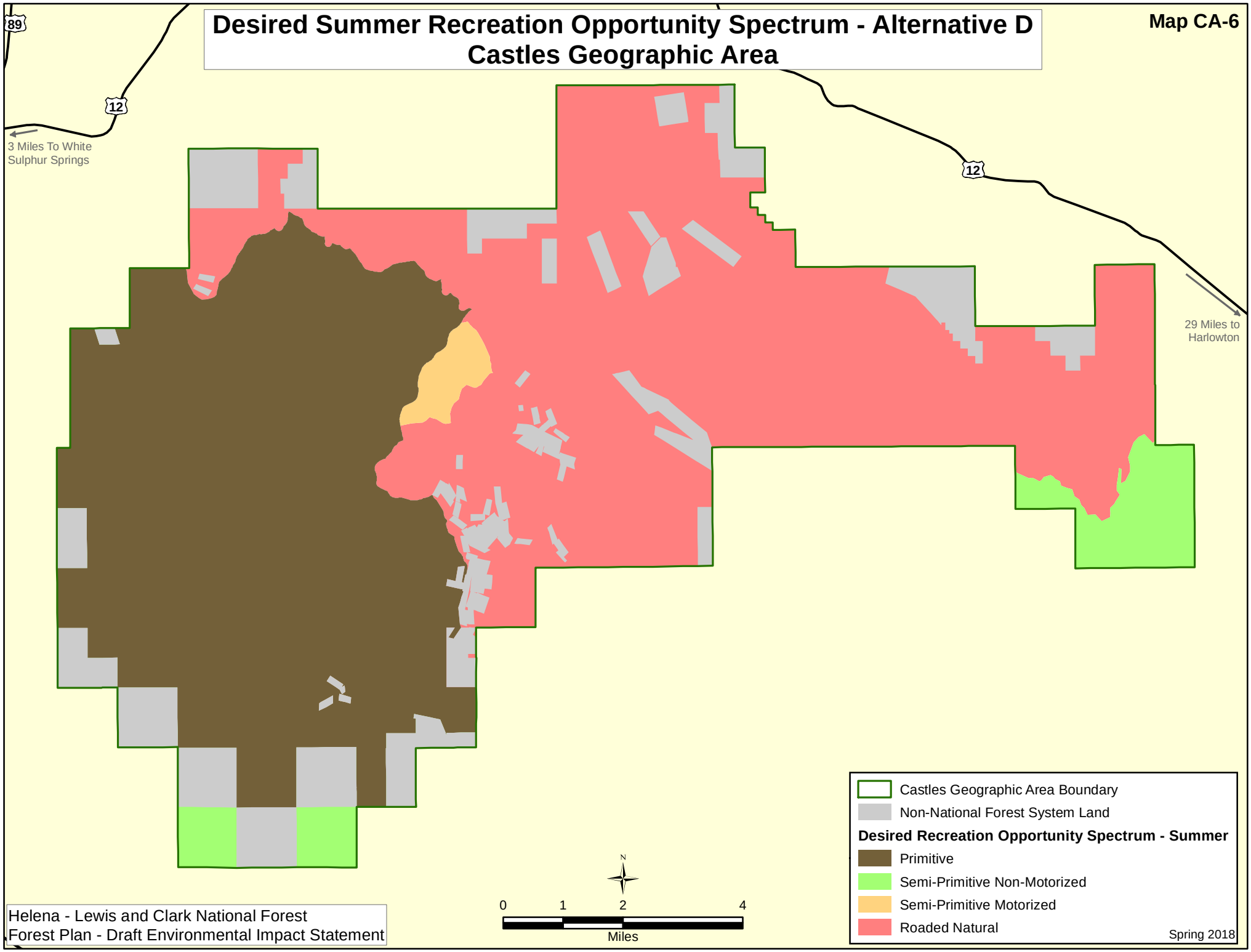
Map CA-5



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Castles Geographic Area

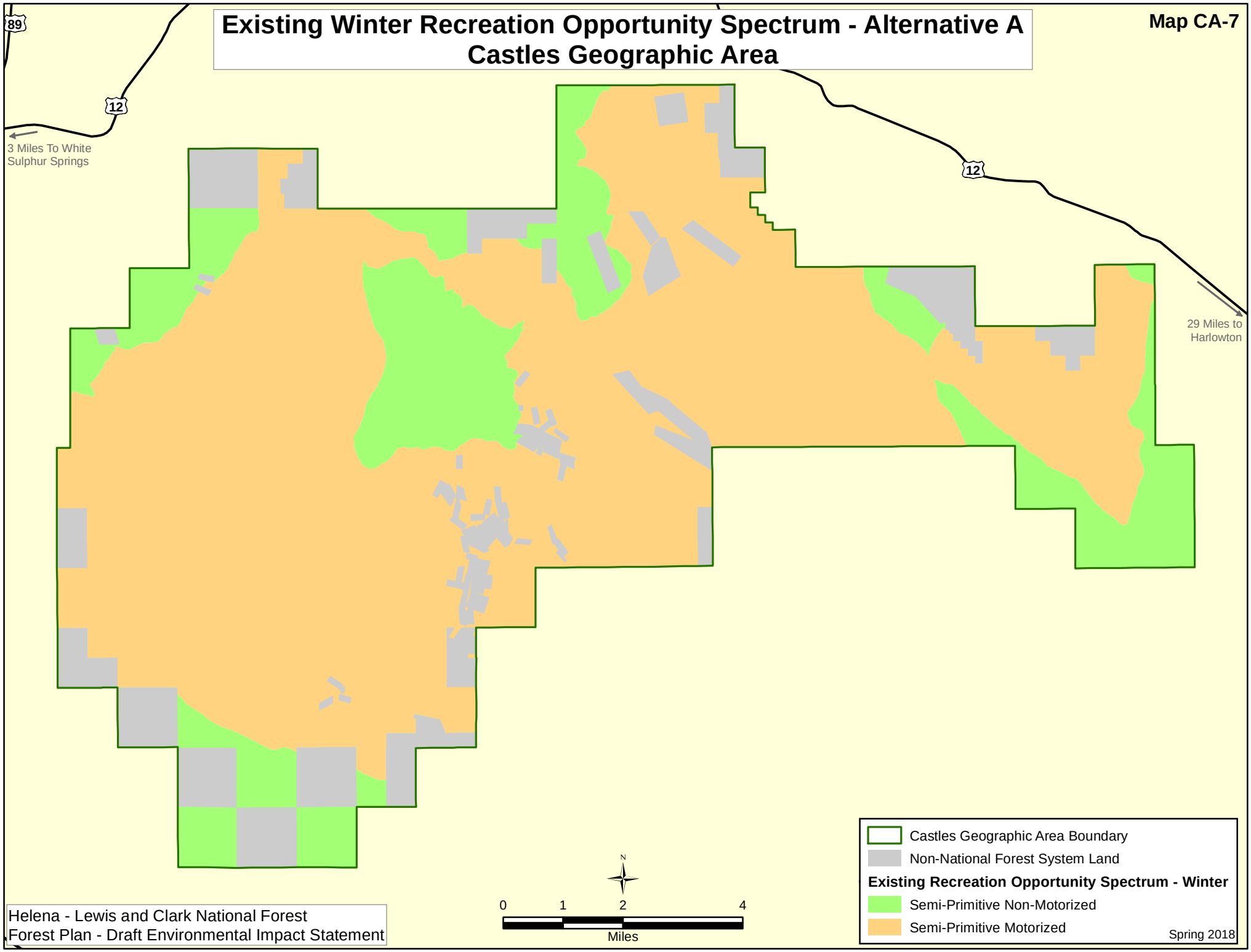
Map CA-6



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Castles Geographic Area

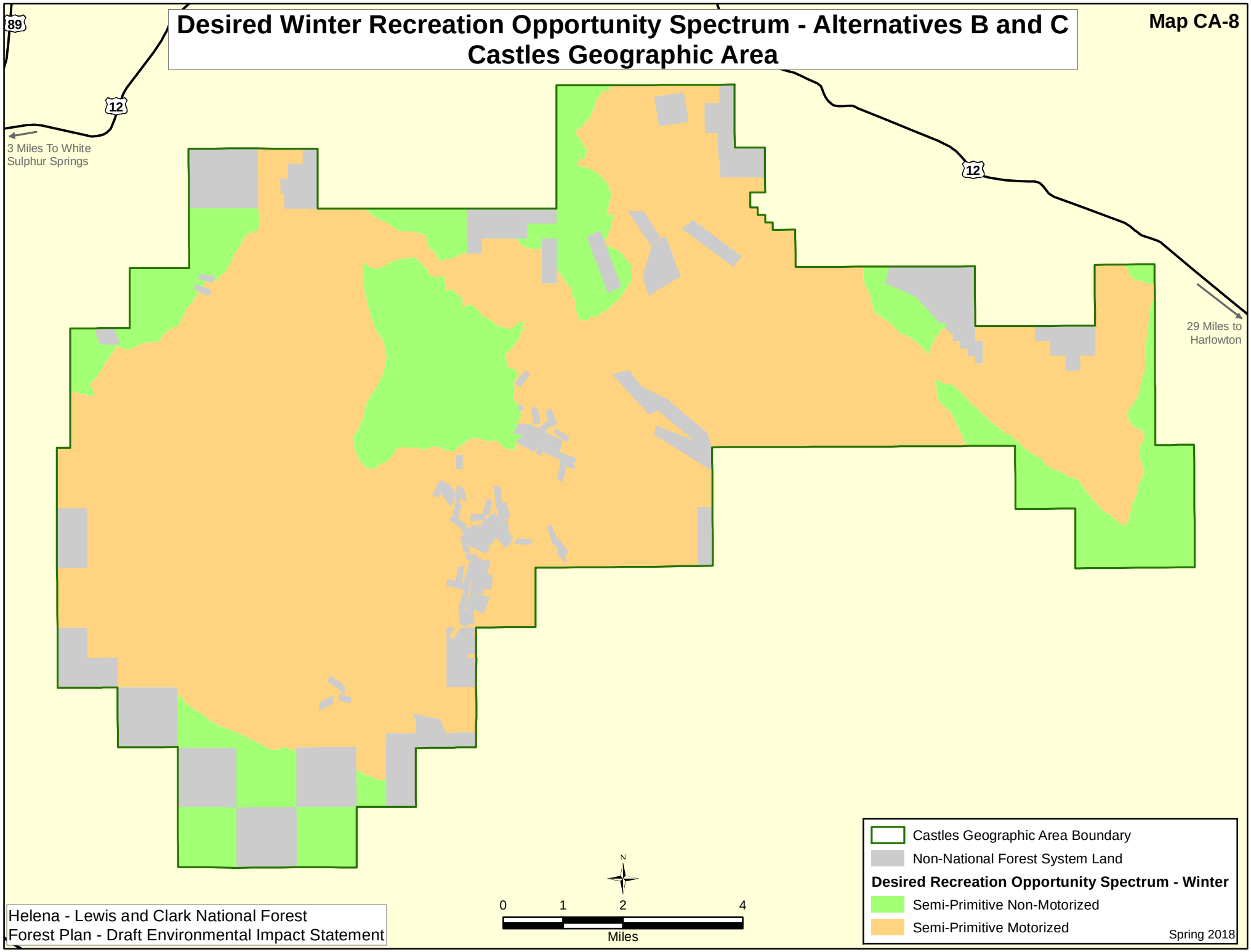
Map CA-7



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Desired Winter Recreation Opportunity Spectrum - Alternatives B and C
Castles Geographic Area

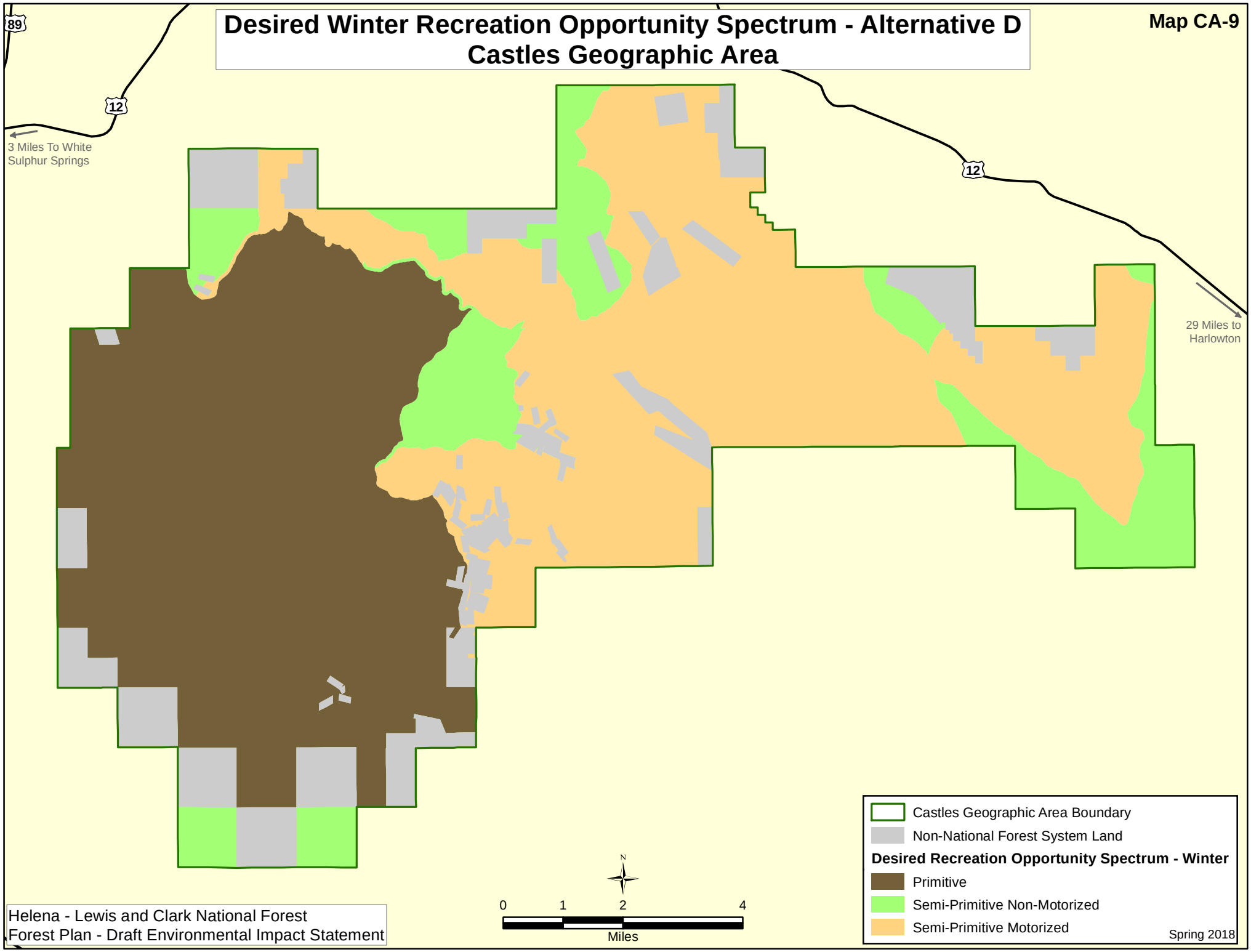
Map CA-8



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Desired Winter Recreation Opportunity Spectrum - Alternative D
Castles Geographic Area

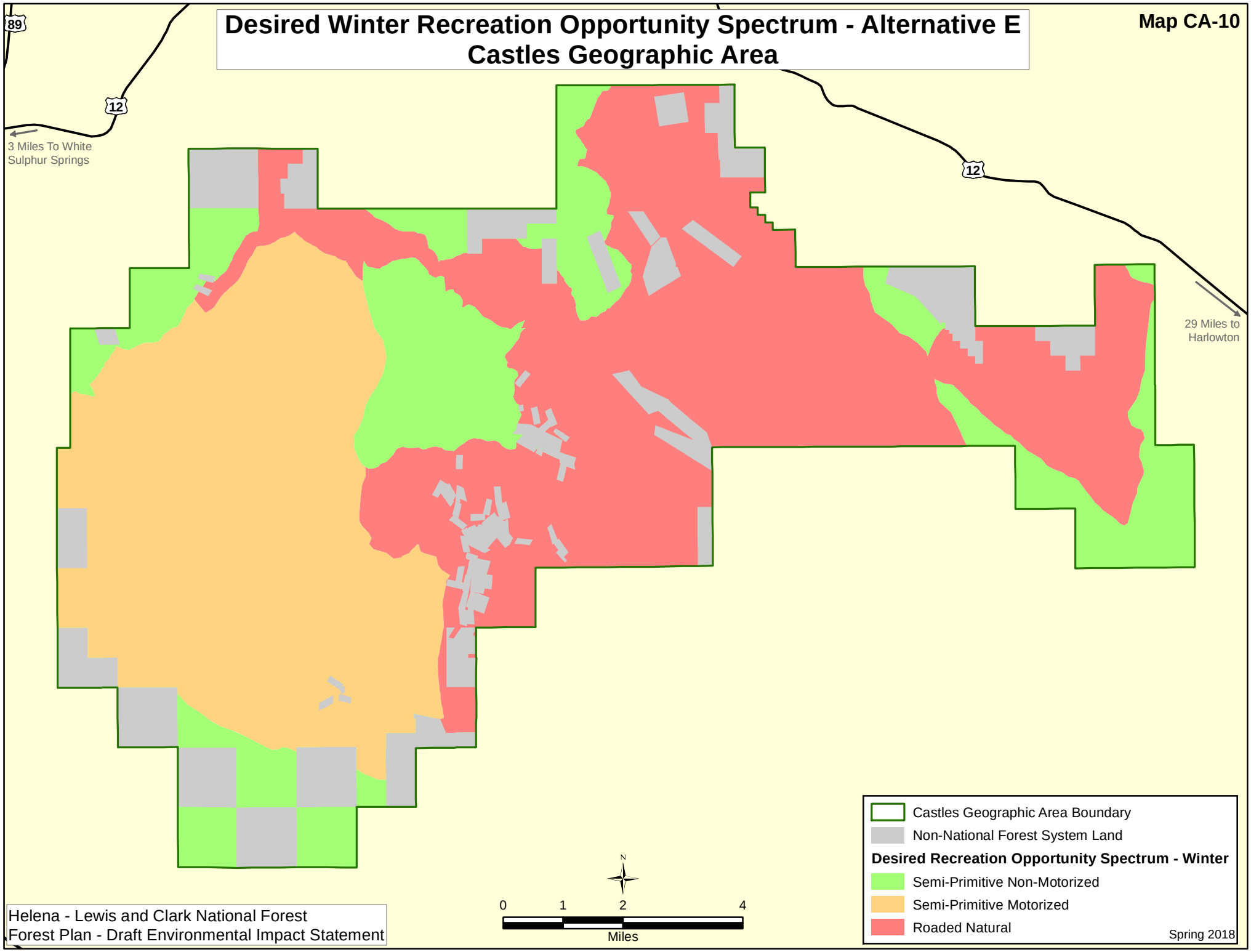
Map CA-9



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Desired Winter Recreation Opportunity Spectrum - Alternative E
Castles Geographic Area

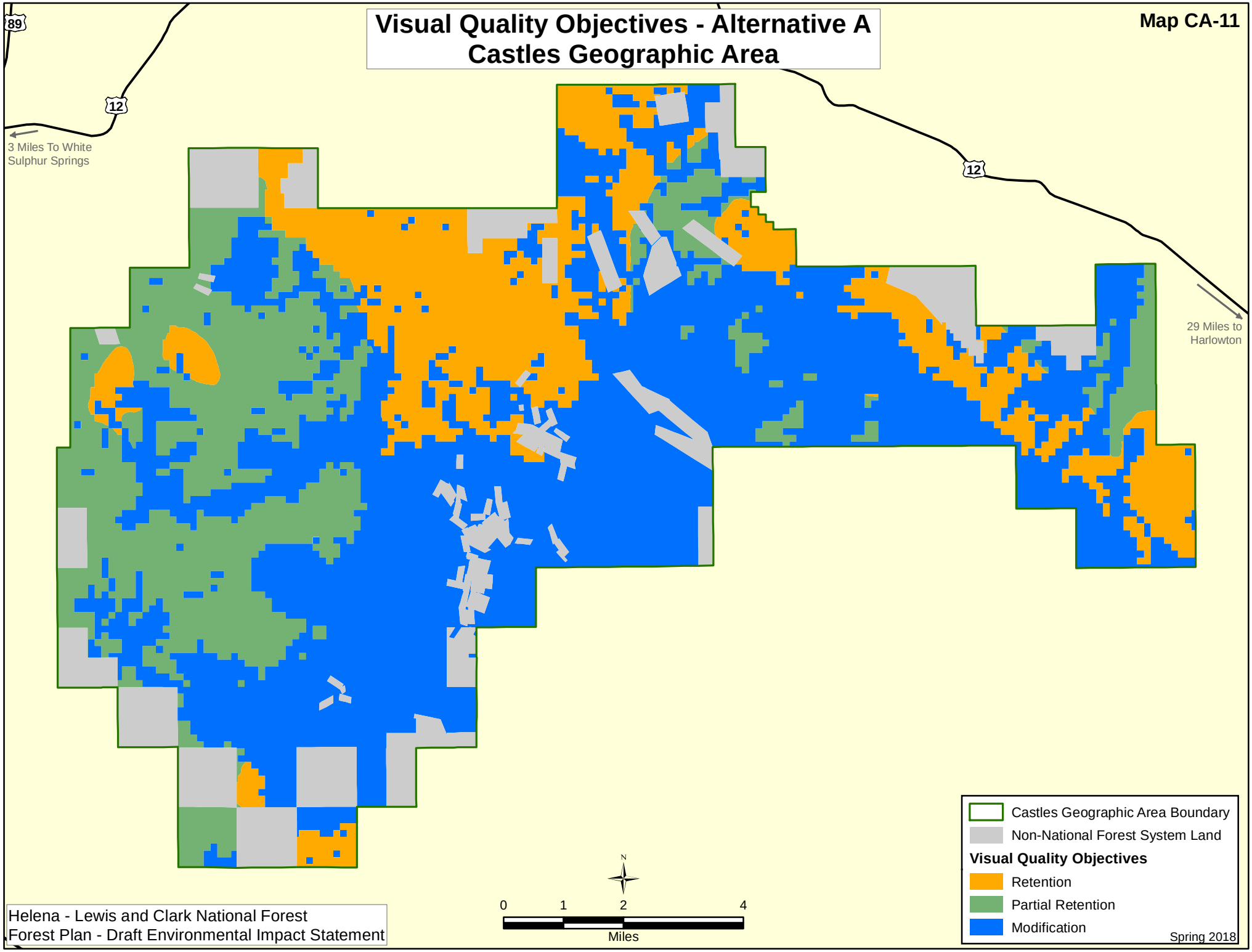
Map CA-10



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Visual Quality Objectives - Alternative A
Castles Geographic Area

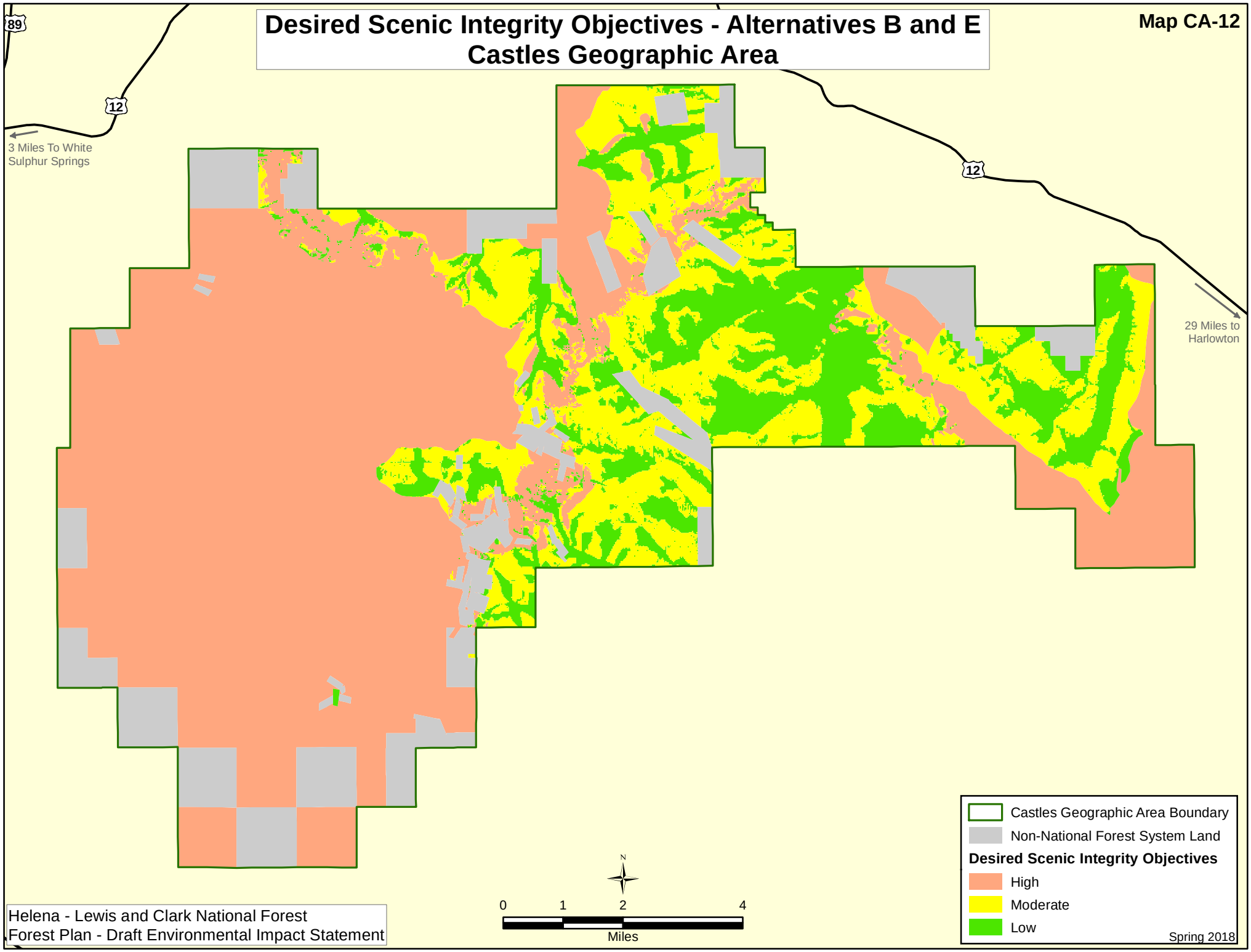
Map CA-11



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Desired Scenic Integrity Objectives - Alternatives B and E
Castles Geographic Area

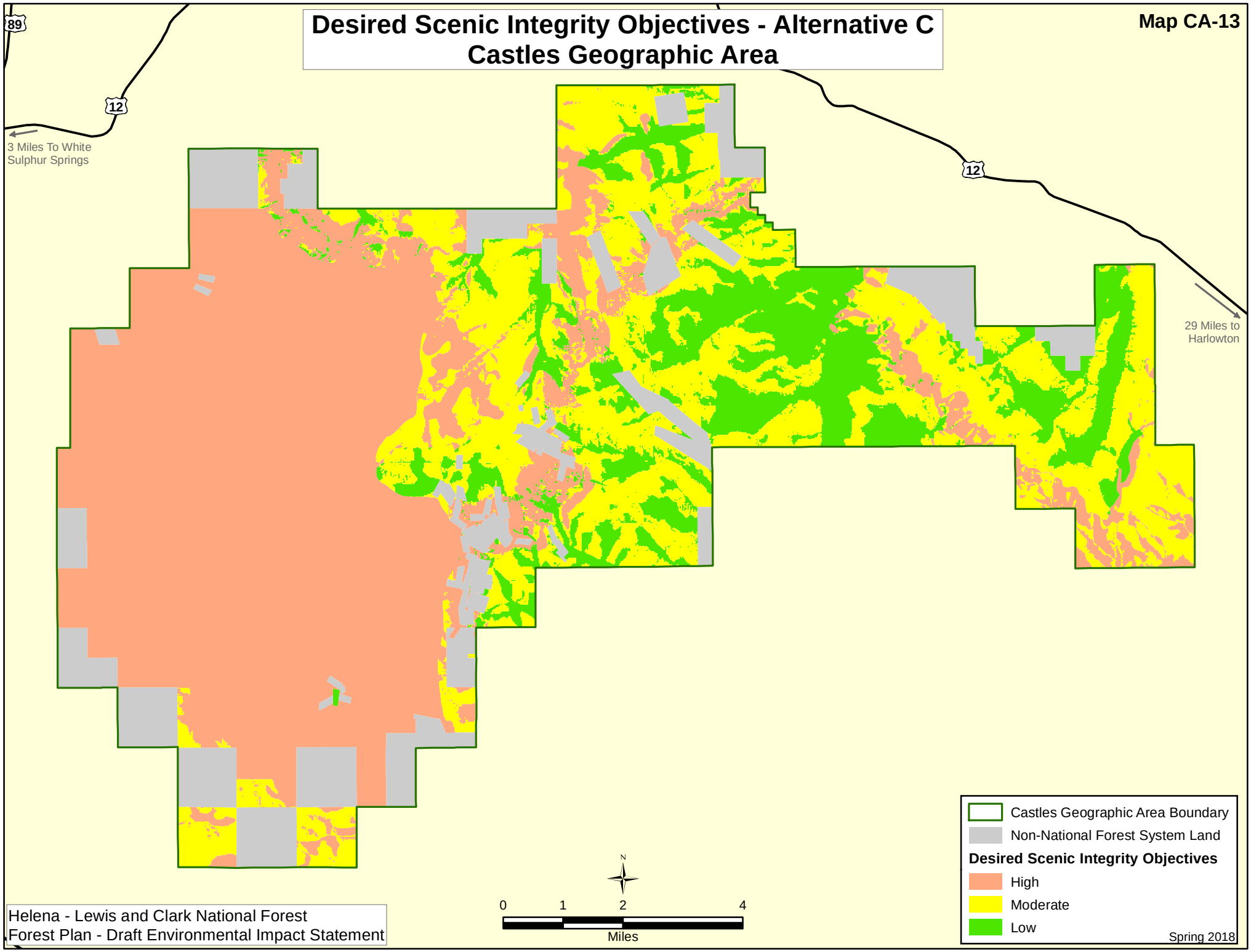
Map CA-12



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Desired Scenic Integrity Objectives - Alternative C
Castles Geographic Area

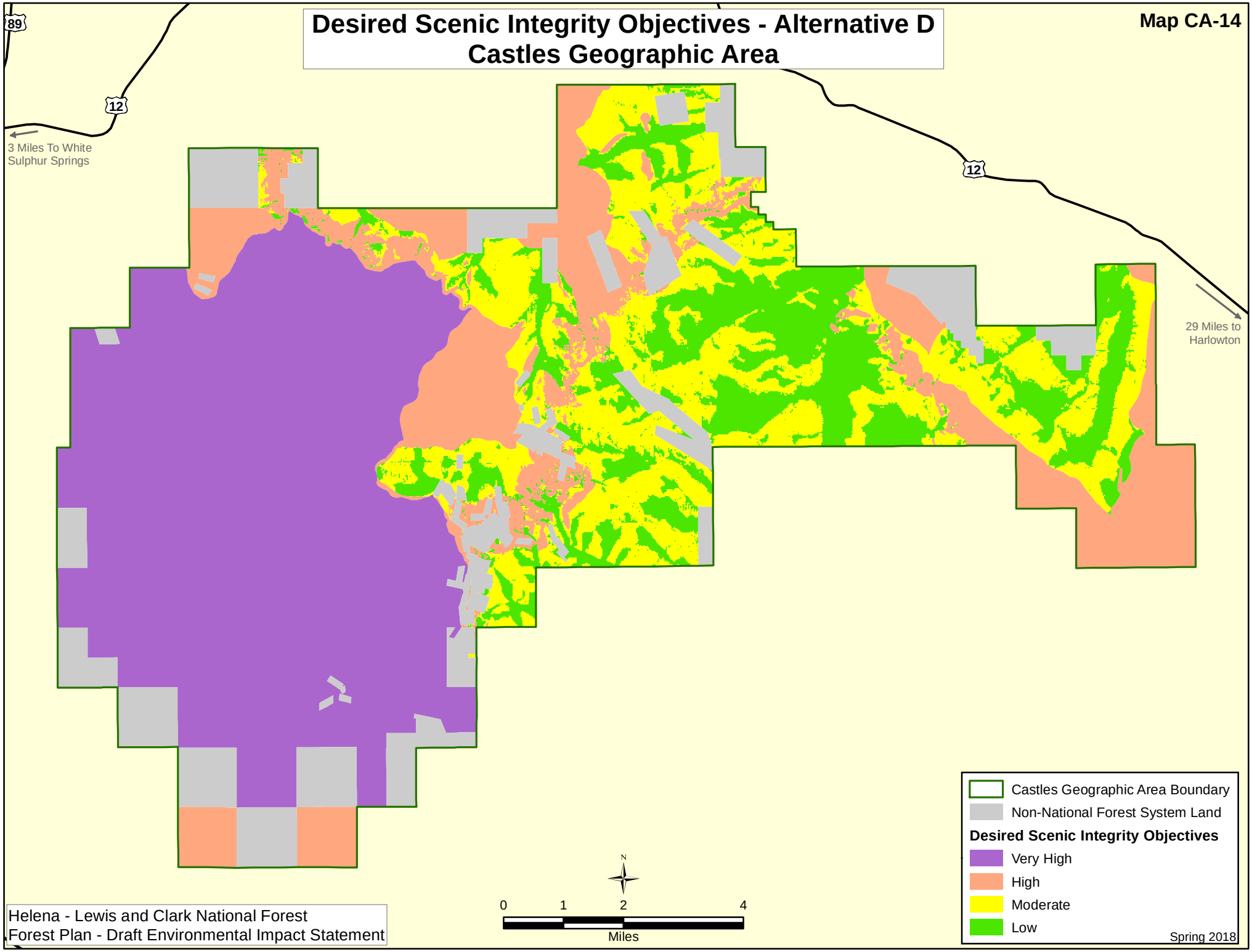
Map CA-13



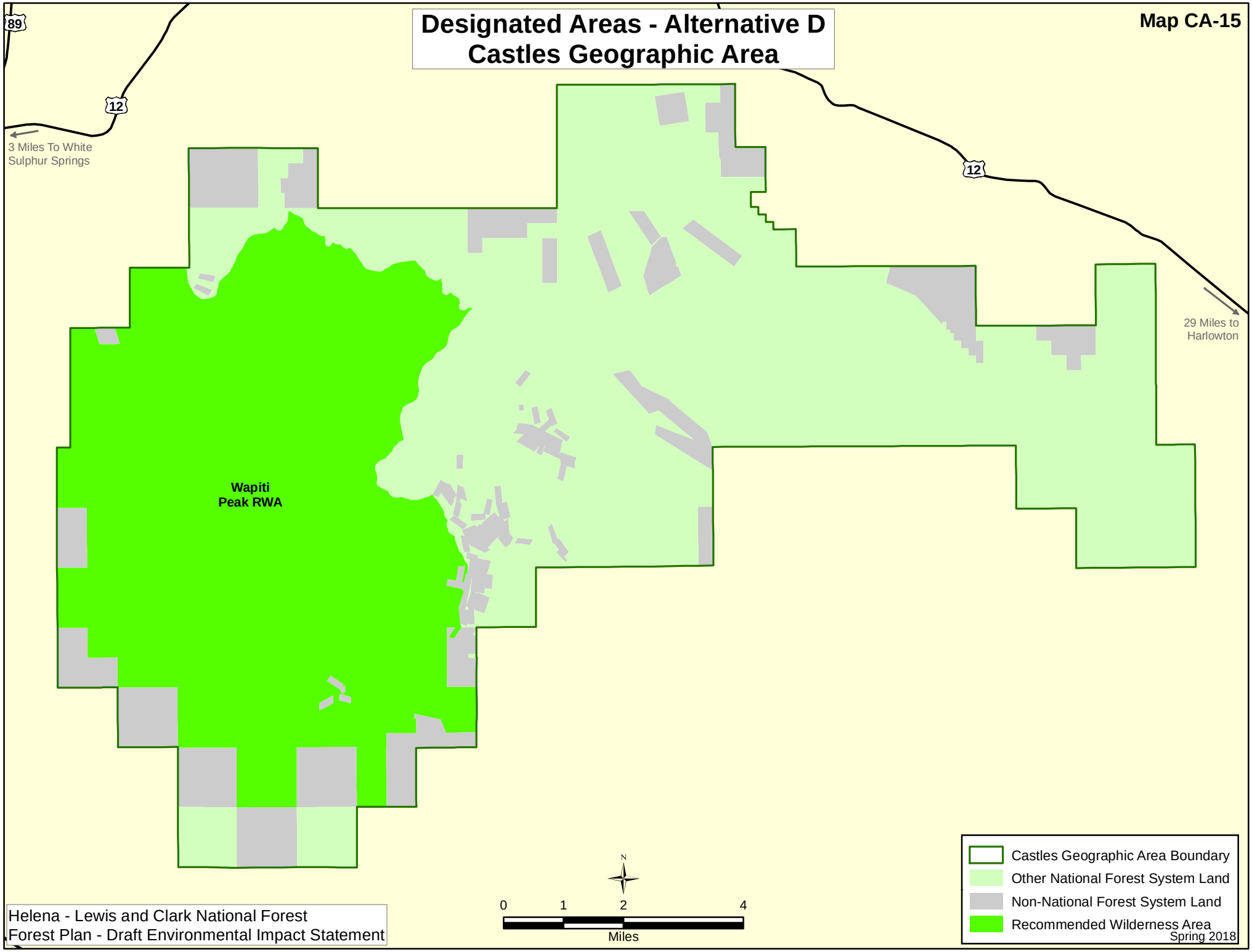
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Desired Scenic Integrity Objectives - Alternative D
Castles Geographic Area

Map CA-14

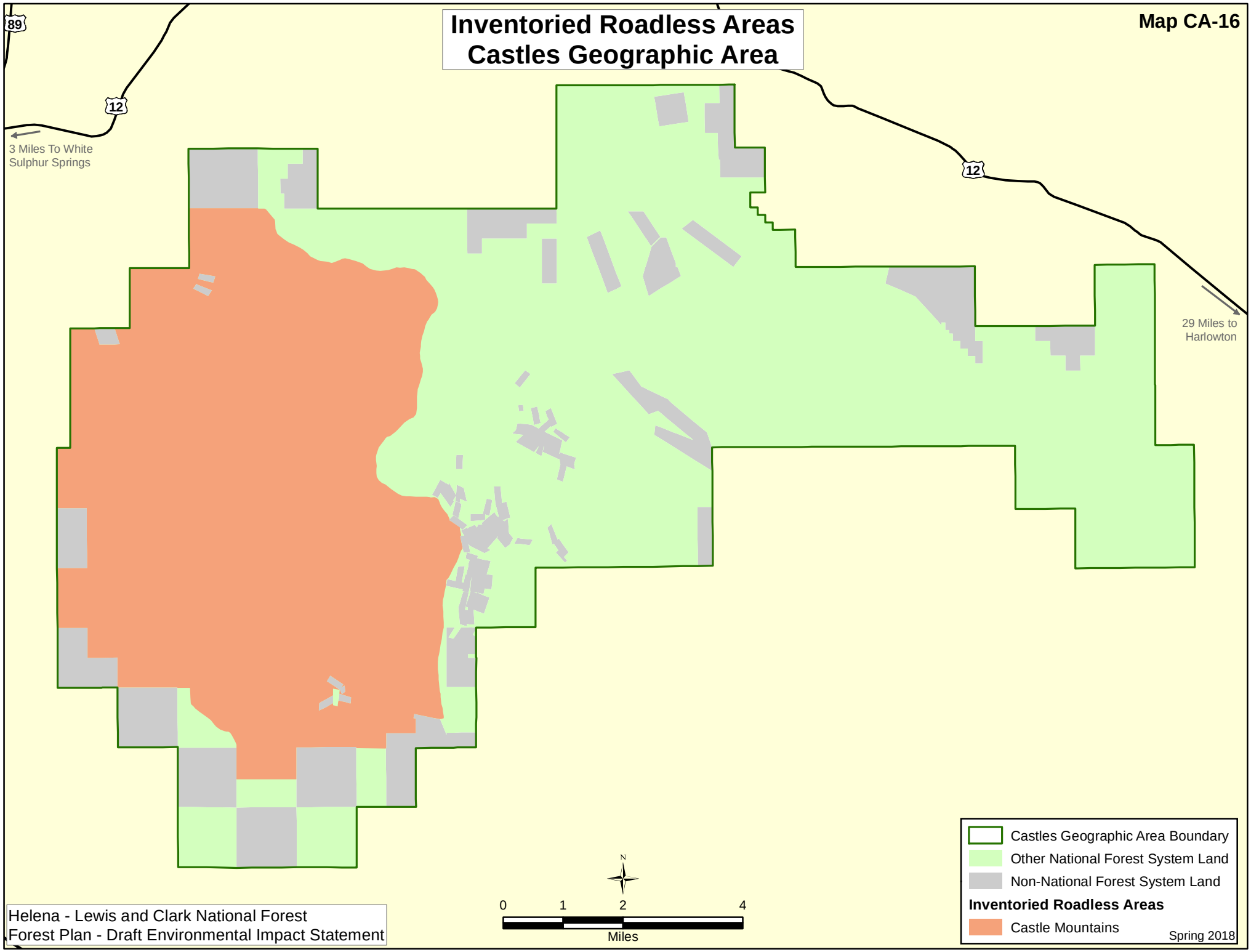


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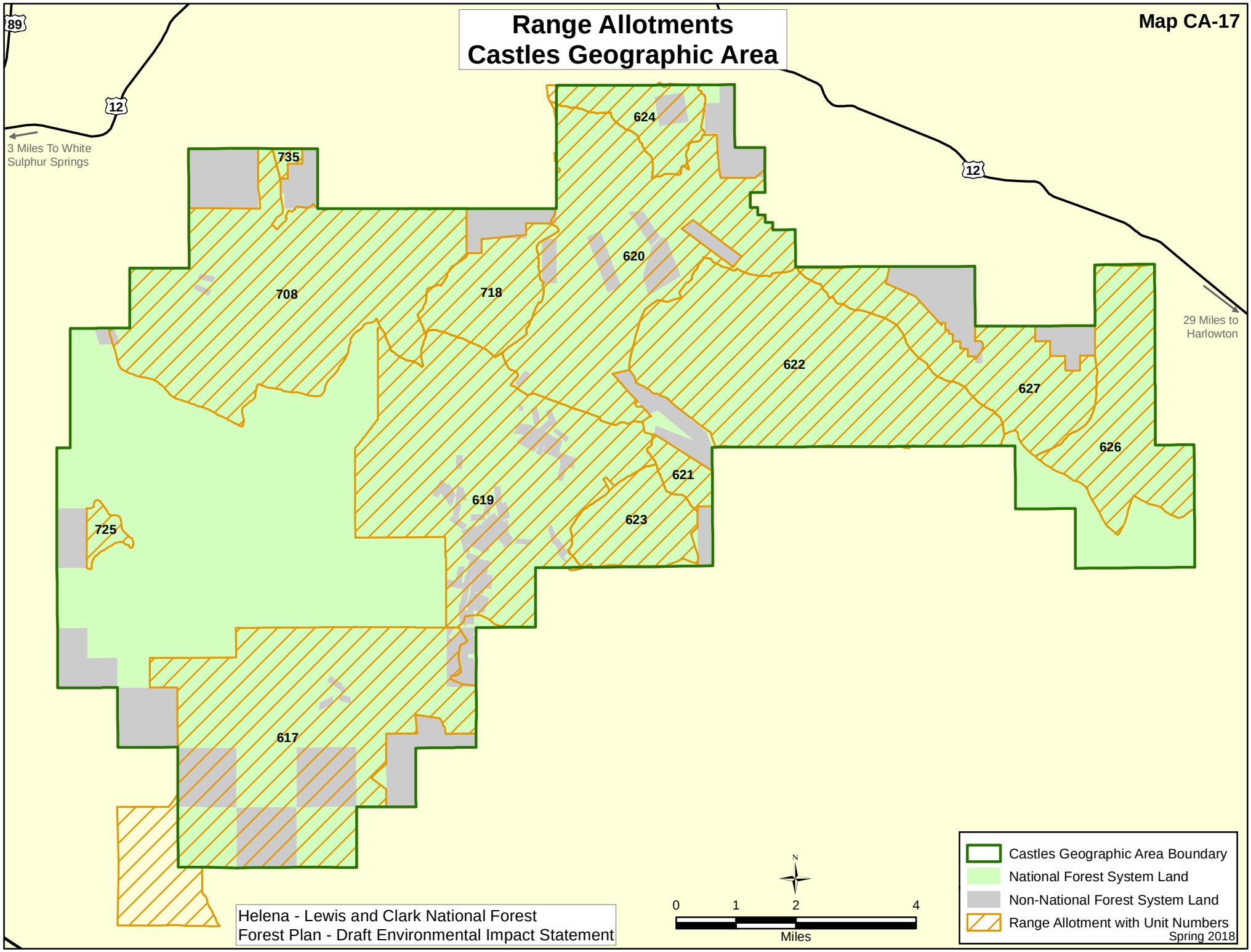

Designated Areas - Alternative D
Castles Geographic Area
Map CA-15
89
12
3 Miles To White
Sulphur Springs
12
29 Miles to
Harlowton
Wapiti
Peak RWA
N
0
1
2
4
Miles
Castles Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Recommended Wilderness Area
Spring 2018
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Inventoried Roadless Areas
Castles Geographic Area

Map CA-16

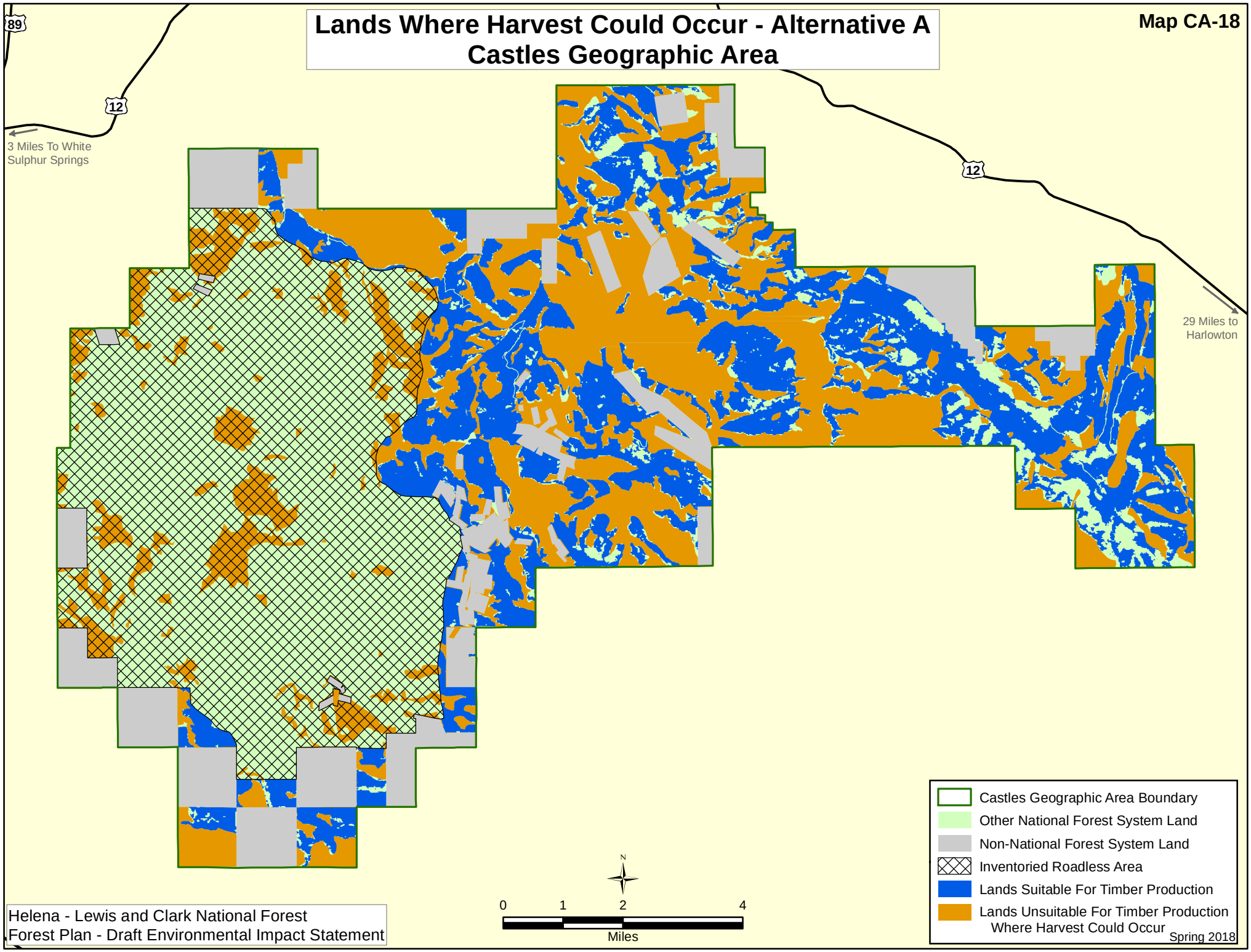


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Range Allotments
Castles Geographic Area
Map CA-17
89
12
3 Miles To White
Sulphur Springs
12
29 Miles to
Harlowton
624
735
620
708
718
622
627
626
621
619
623
725
617
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N
0
1
2
4
Miles
Castles Geographic Area Boundary
National Forest System Land
Non-National Forest System Land
Range Allotment with Unit Numbers
Spring 2018

Lands Where Harvest Could Occur - Alternative A
Castles Geographic Area

Map CA-18

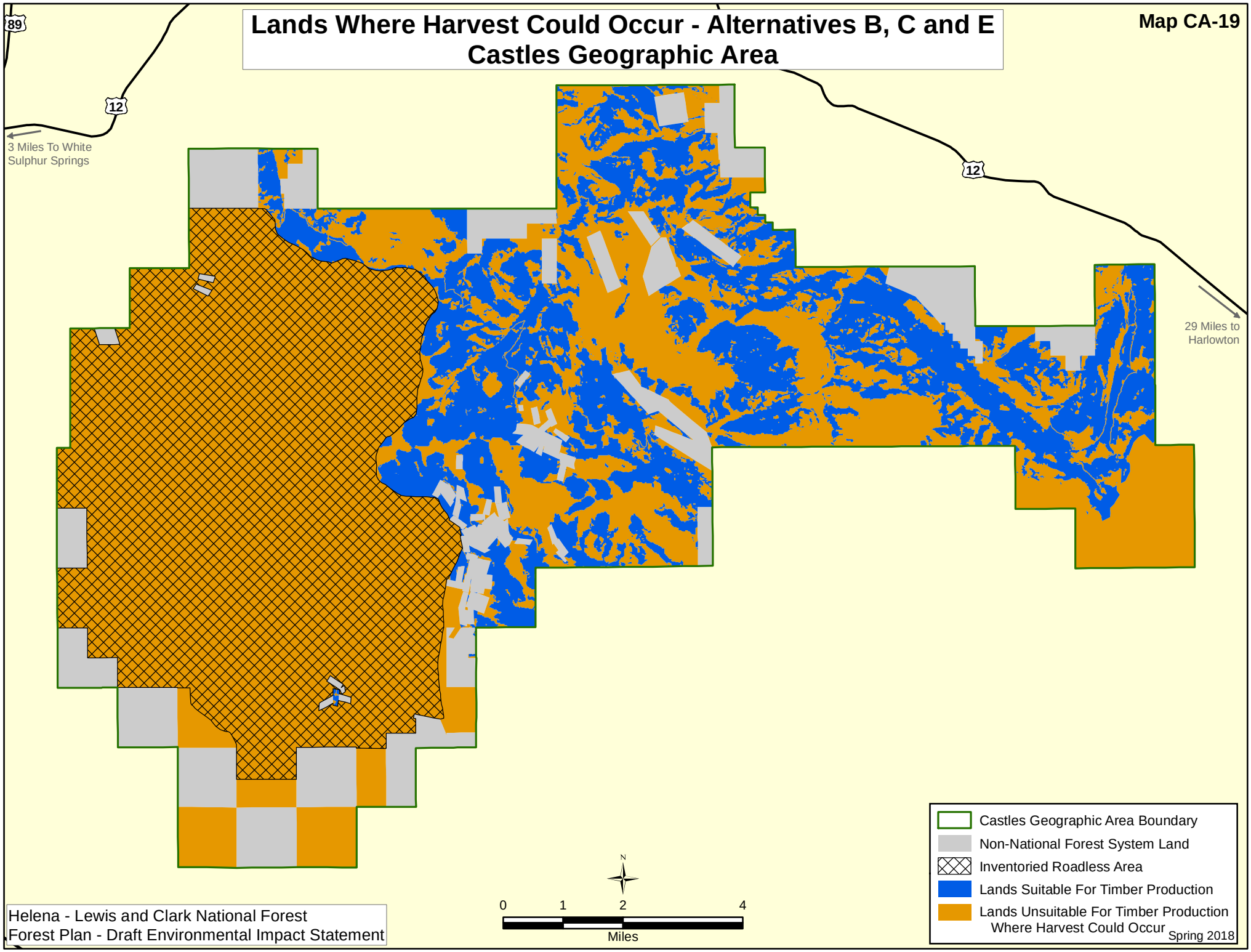


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Lands Where Harvest Could Occur - Alternatives B, C and E
Castles Geographic Area

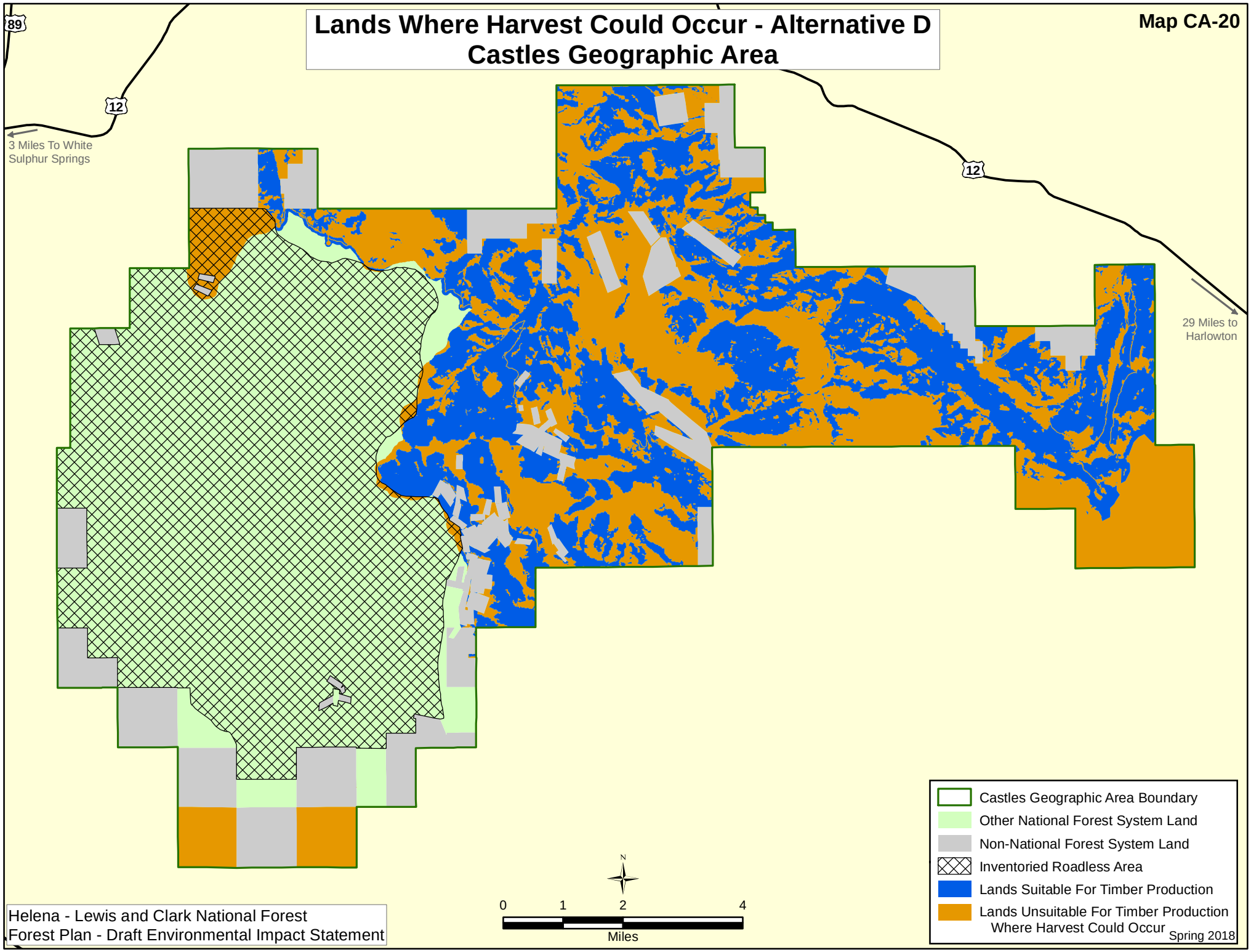
Map CA-19



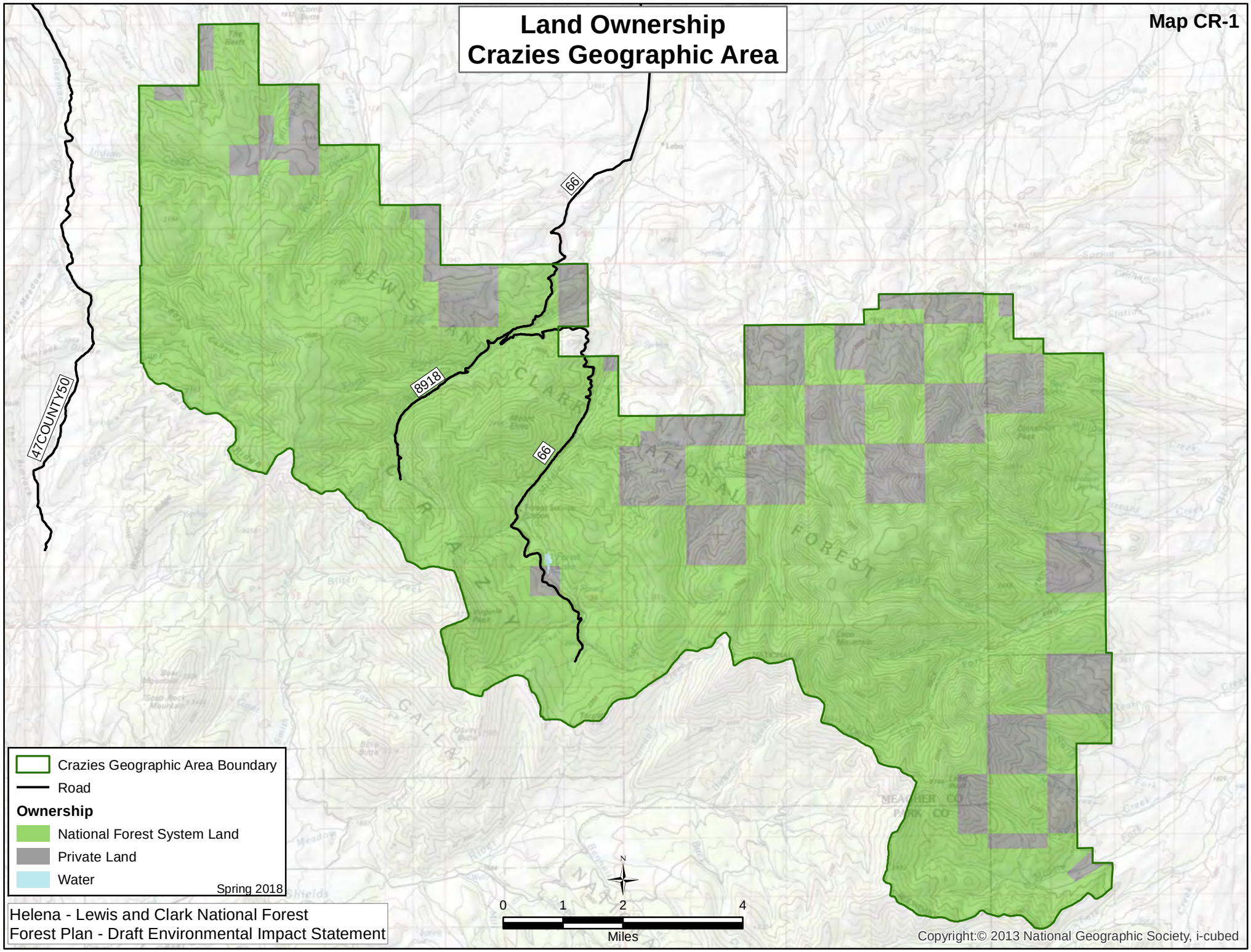
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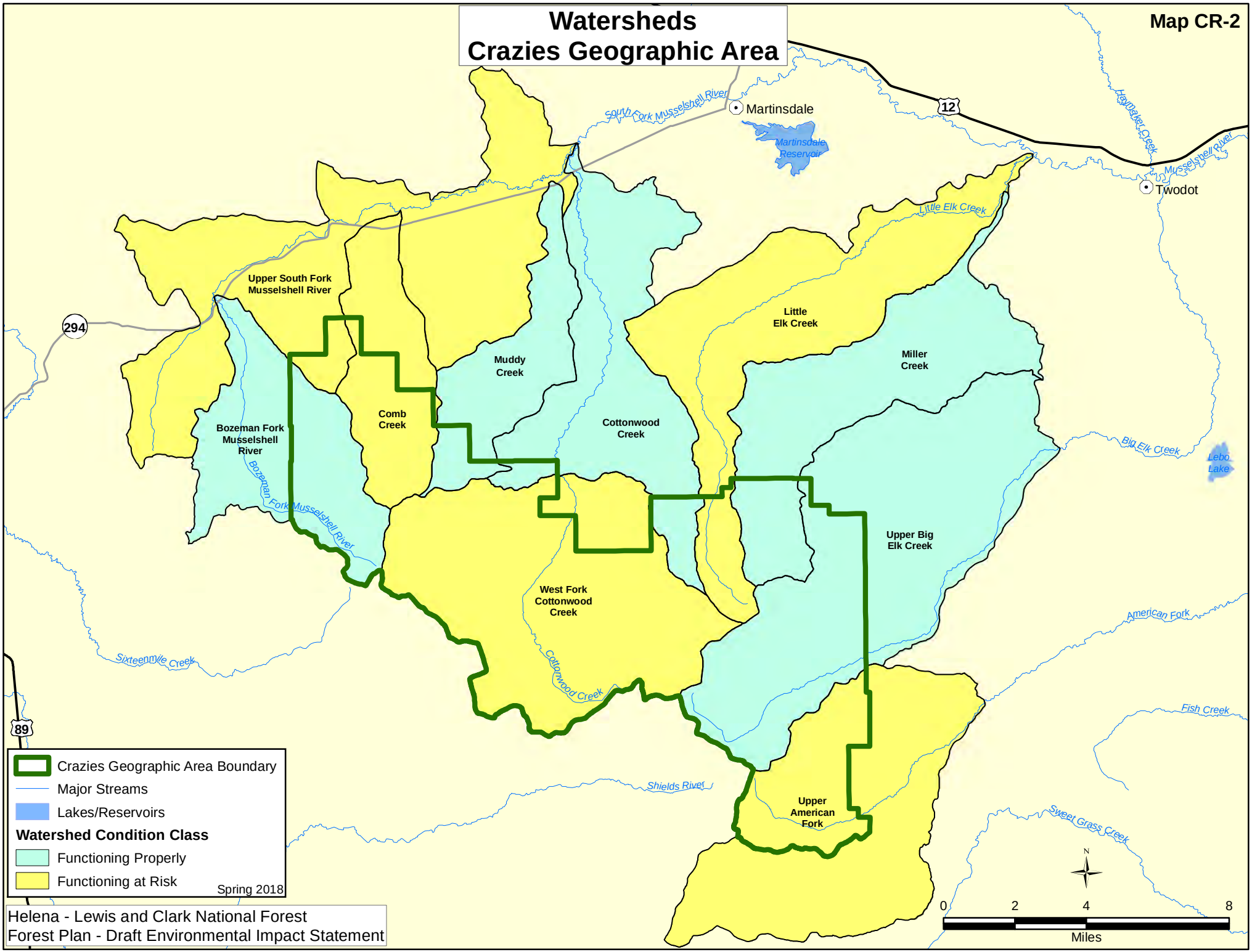
Lands Where Harvest Could Occur - Alternative D
Castles Geographic Area

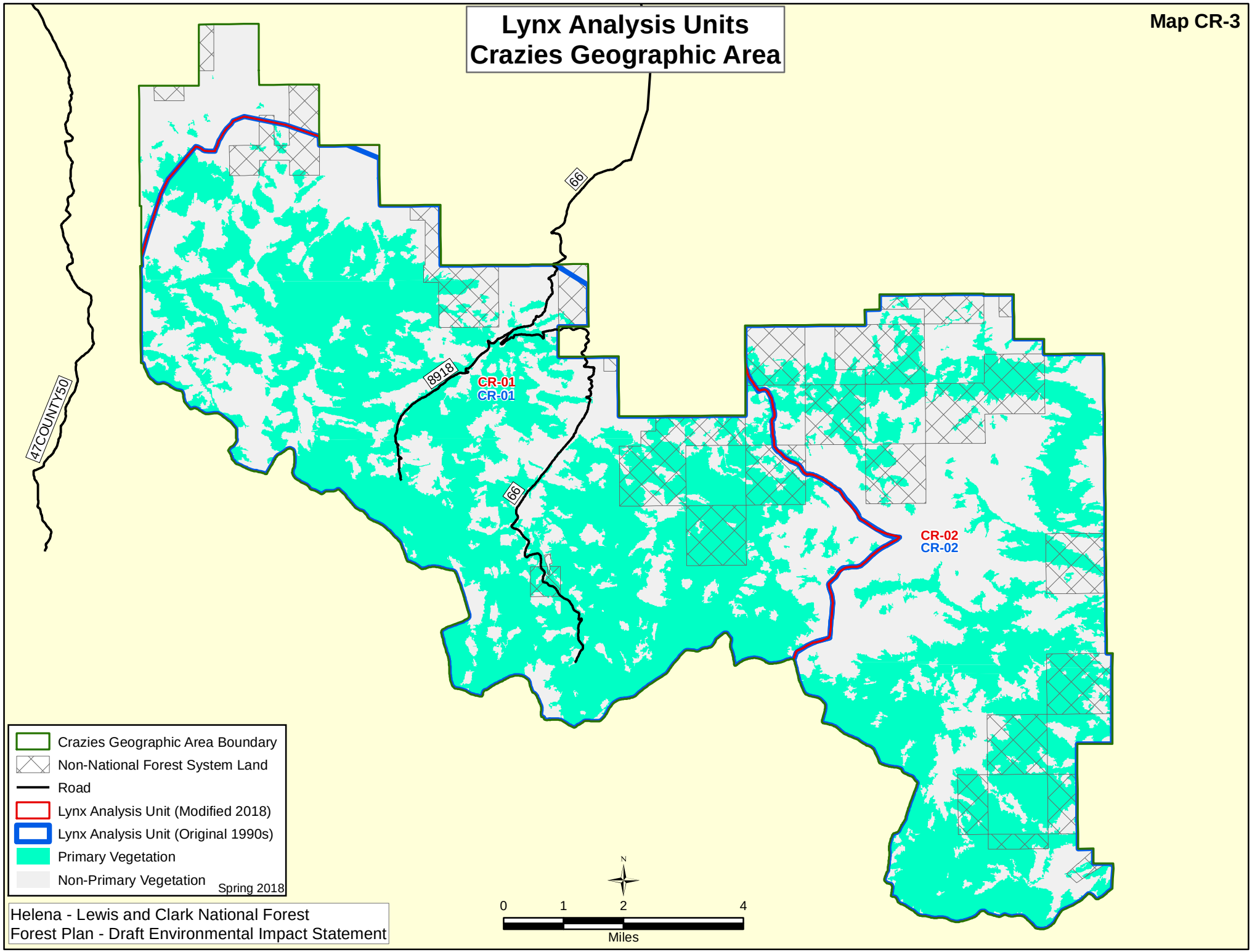
Map CA-20



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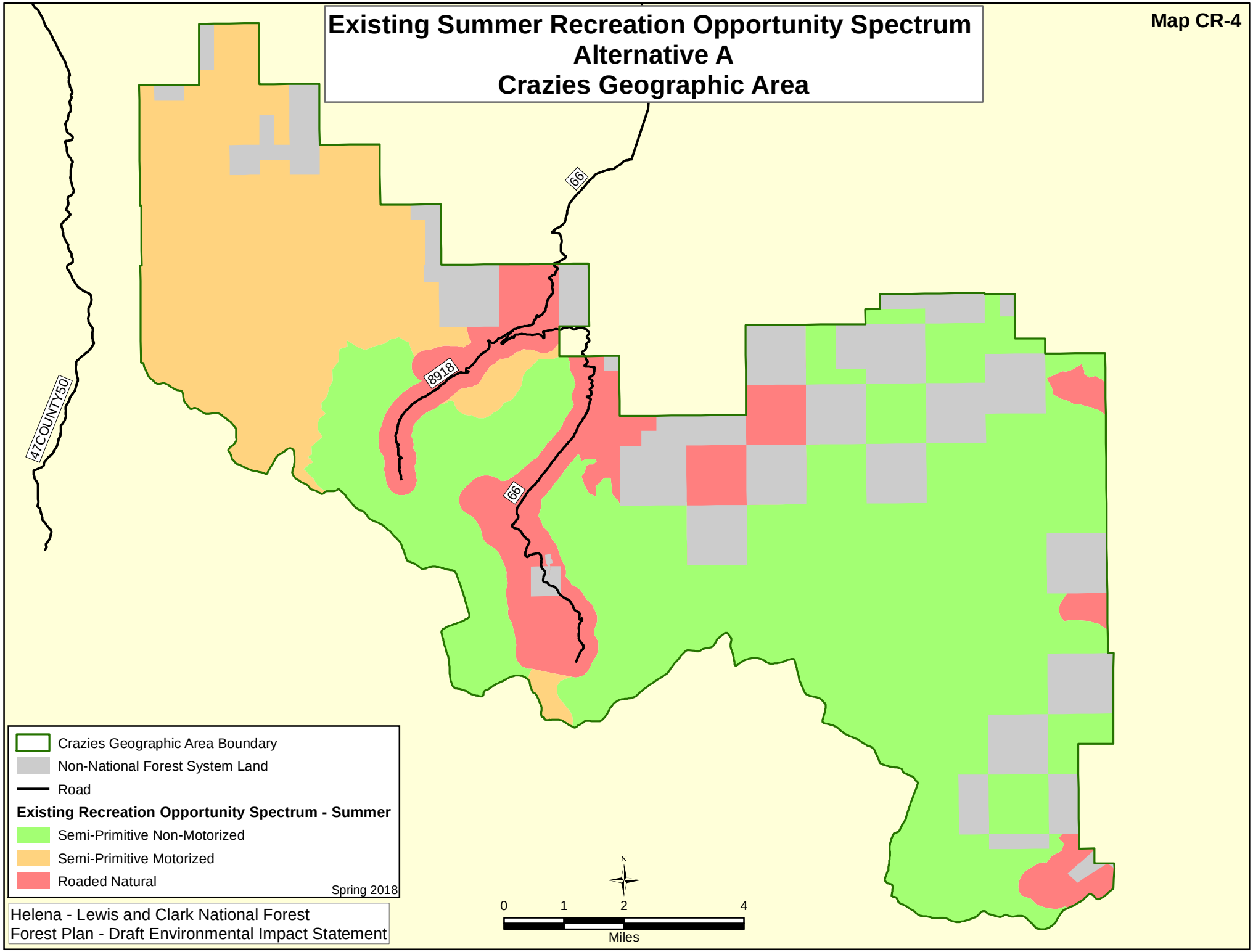

Land Ownership
Crazies Geographic Area
Map CR-1
66
8918
47COUNTY50
LEWIS AND CLARK NATIONAL FOREST
Crazies Geographic Area Boundary
Road
Ownership
National Forest System Land
Private Land
Water
Spring 2018
N
0
1
2
4
Miles
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Watersheds
Crazies Geographic Area
Map CR-2
Martinsdale
Martinsdale Reservoir
South Fork Musselshell River
12
Haymaker Creek
Musselshell River
Twodot
Little Elk Creek
Upper South Fork Musselshell River
294
Little Elk Creek
Miller Creek
Muddy Creek
Comb Creek
Cottonwood Creek
Bozeman Fork Musselshell River
Bozeman Fork Musselshell River
Big Elk Creek
Lebo Lake
Upper Big Elk Creek
West Fork Cottonwood Creek
American Fork
Sixteenmile Creek
Cottonwood Creek
89
Fish Creek
Shields River
Upper American Fork
Sweet Grass Creek
Crazies Geographic Area Boundary
Major Streams
Lakes/Reservoirs
Watershed Condition Class
Functioning Properly
Functioning at Risk
Spring 2018
N
0
2
4
8
Miles
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Lynx Analysis Units
Crazies Geographic Area
Map CR-3
66
8918
47COUNTY50
CR-01
CR-01
CR-02
CR-02
Crazies Geographic Area Boundary
Non-National Forest System Land
Road
Lynx Analysis Unit (Modified 2018)
Lynx Analysis Unit (Original 1990s)
Primary Vegetation
Non-Primary Vegetation
Spring 2018
N
0
1
2
4
Miles
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Existing Summer Recreation Opportunity Spectrum
Alternative A
Crazies Geographic Area

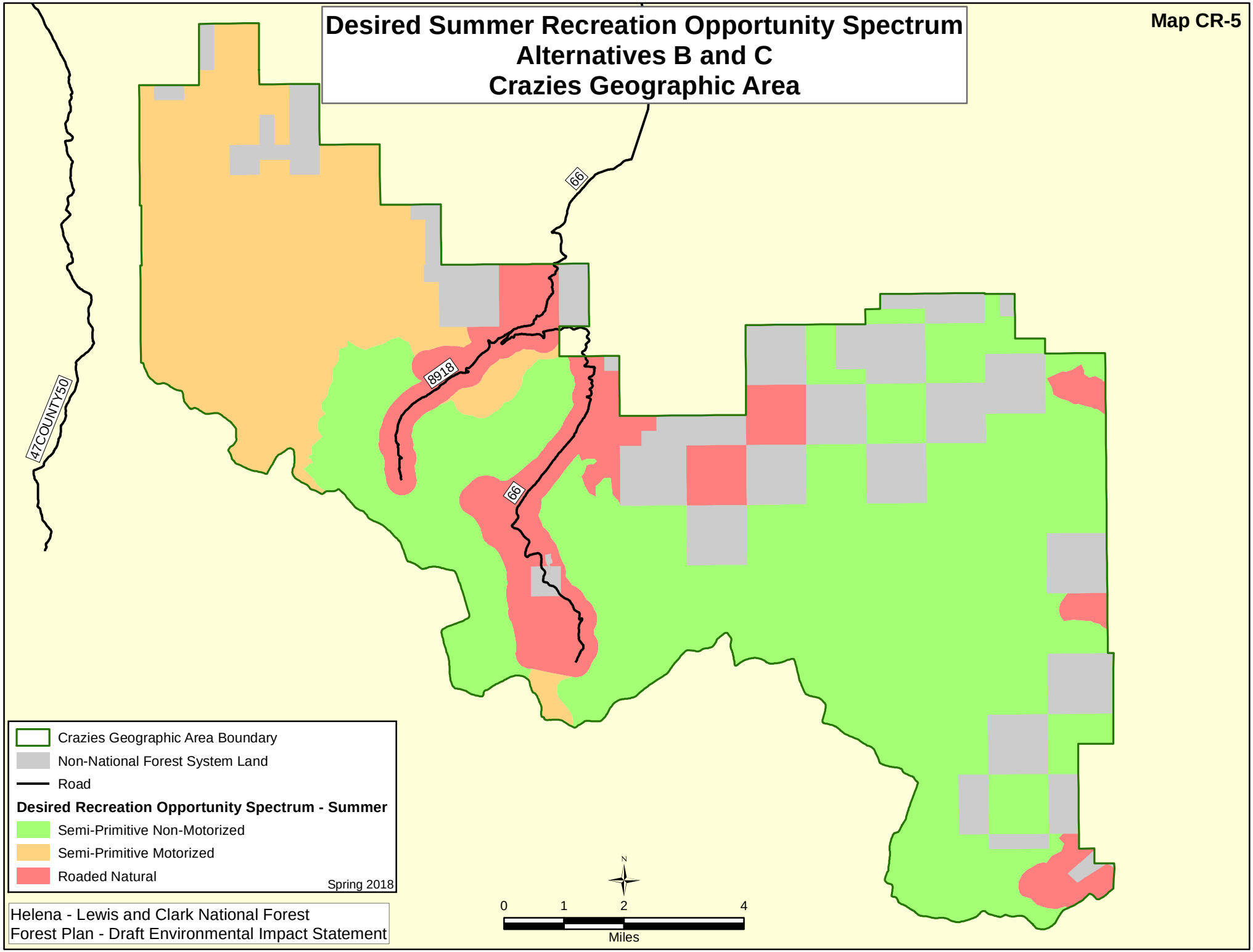
Map CR-4



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Desired Summer Recreation Opportunity Spectrum
Alternatives B and C
Crazies Geographic Area

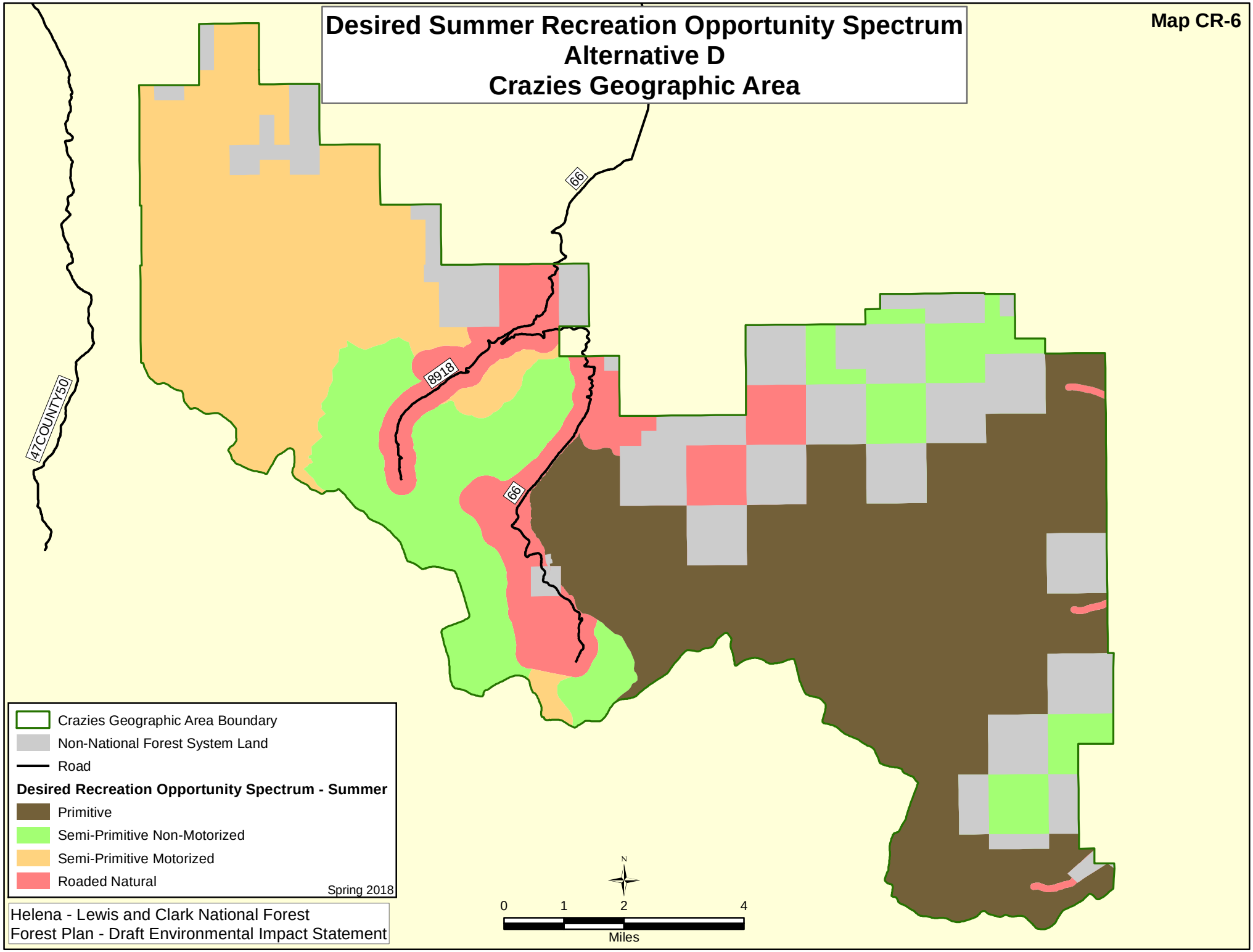
Map CR-5



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Desired Summer Recreation Opportunity Spectrum
Alternative D
Crazies Geographic Area

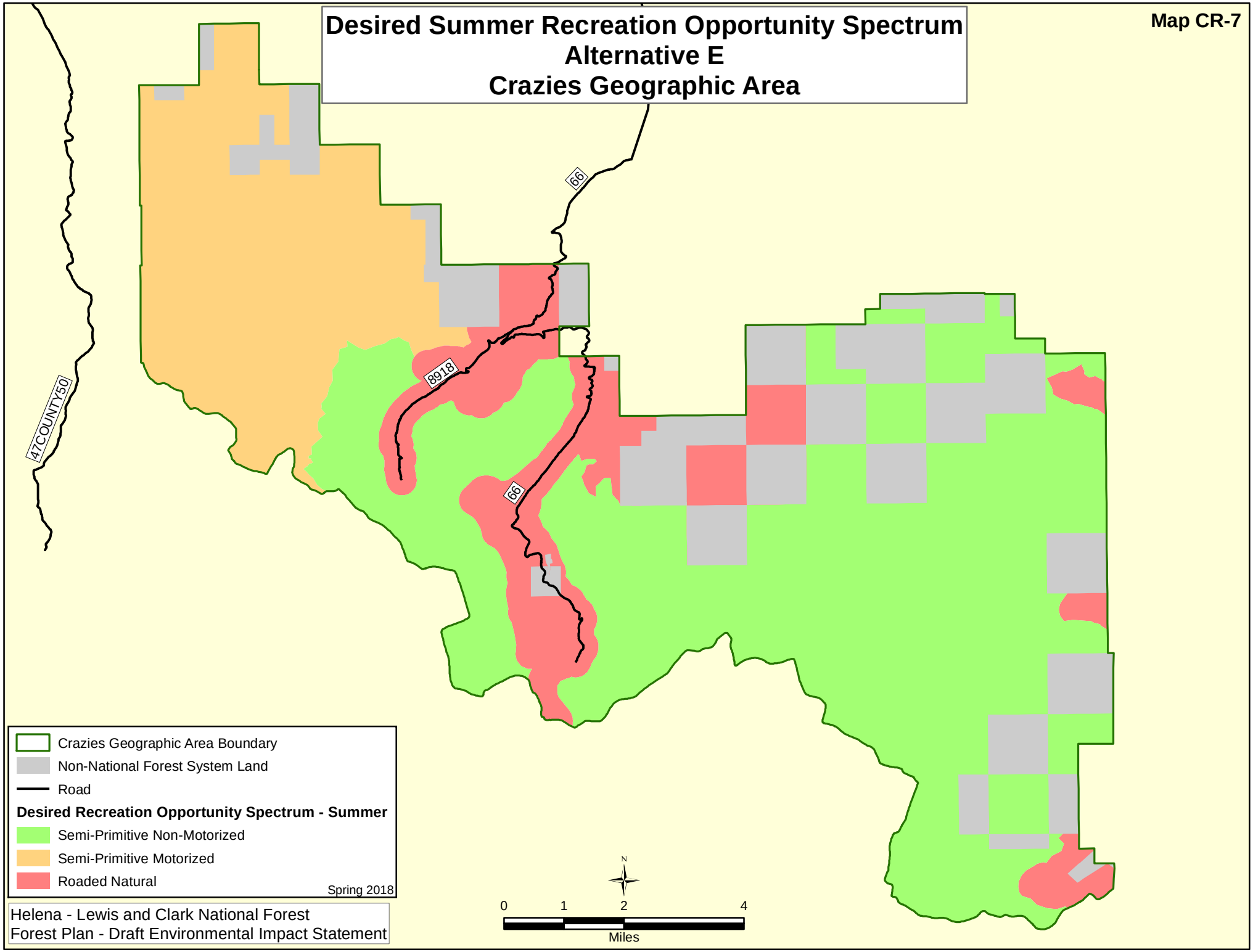
Map CR-6



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Map CR-7

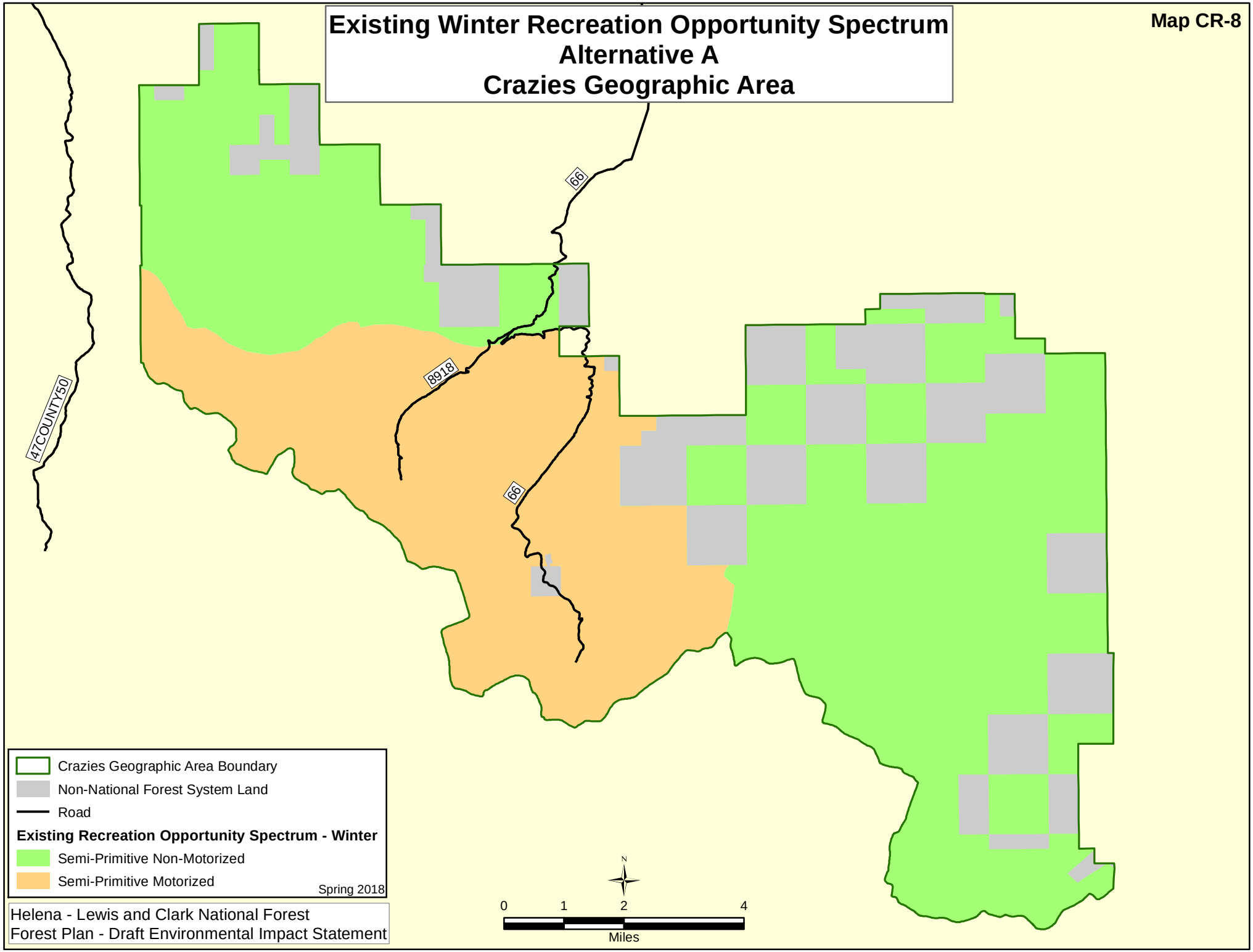
Desired Summer Recreation Opportunity Spectrum
Alternative E
Crazies Geographic Area



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Existing Winter Recreation Opportunity Spectrum
Alternative A
Crazies Geographic Area

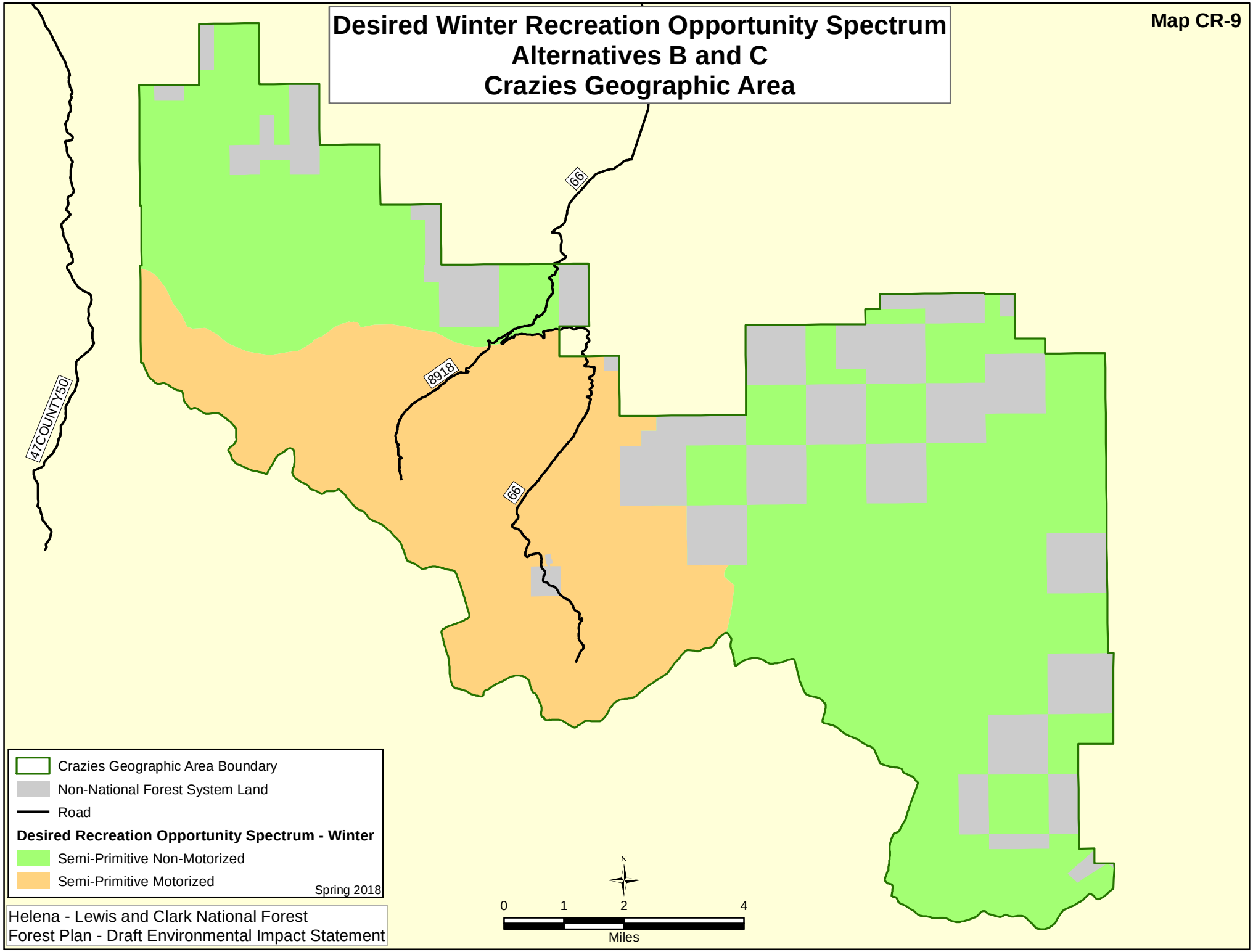
Map CR-8



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Map CR-9

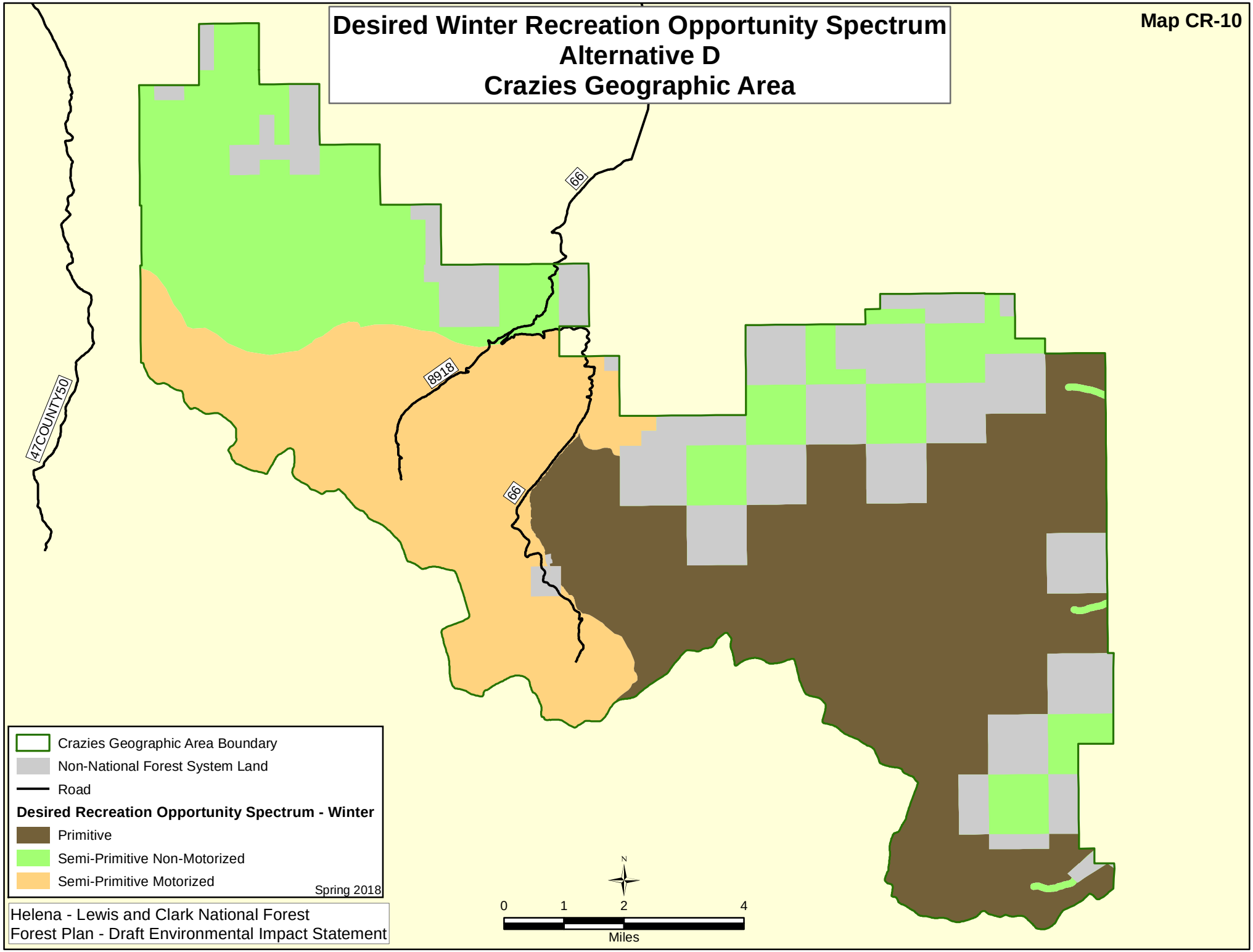
Desired Winter Recreation Opportunity Spectrum
Alternatives B and C
Crazies Geographic Area



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Desired Winter Recreation Opportunity Spectrum
Alternative D
Crazies Geographic Area

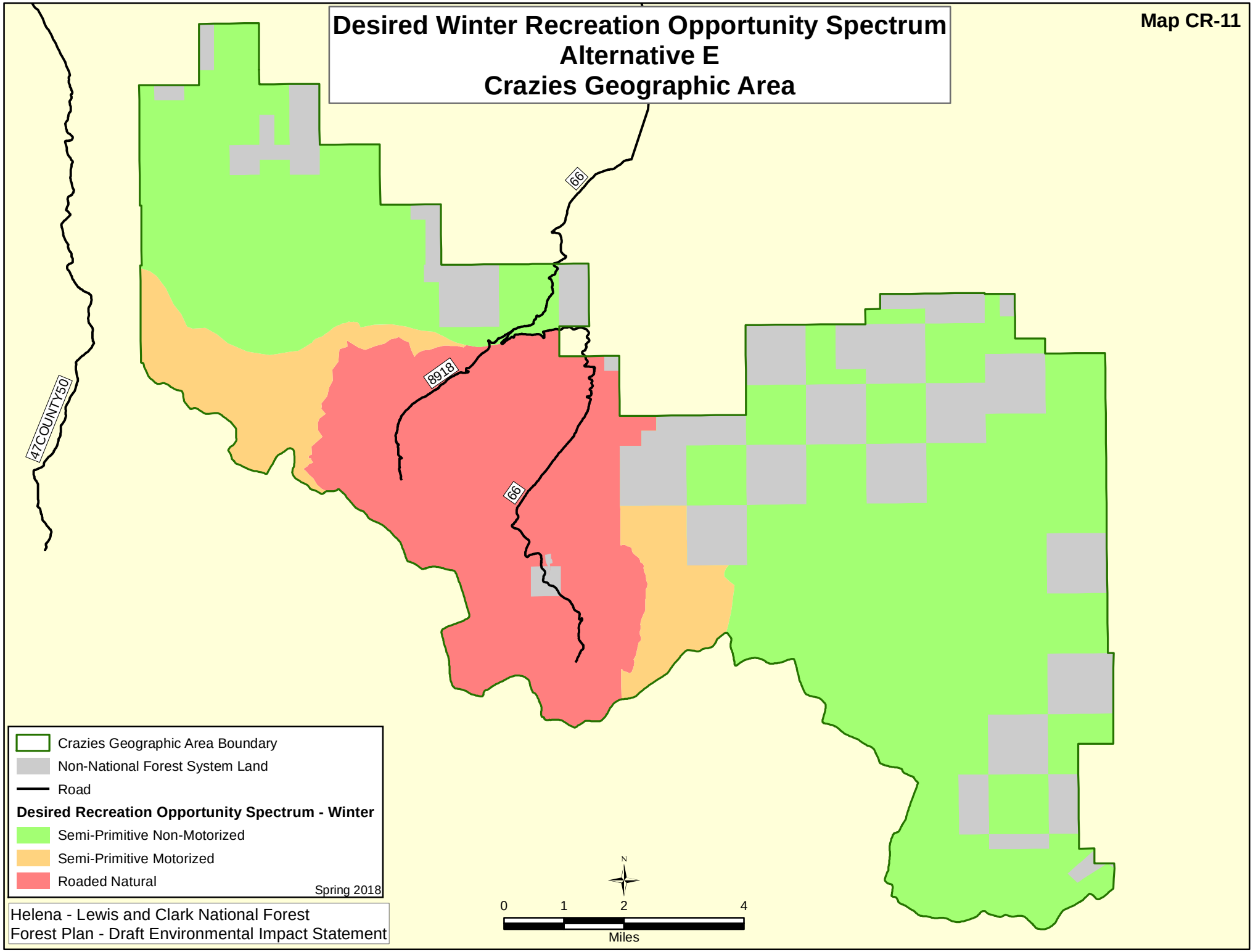
Map CR-10



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Desired Winter Recreation Opportunity Spectrum
Alternative E
Crazies Geographic Area

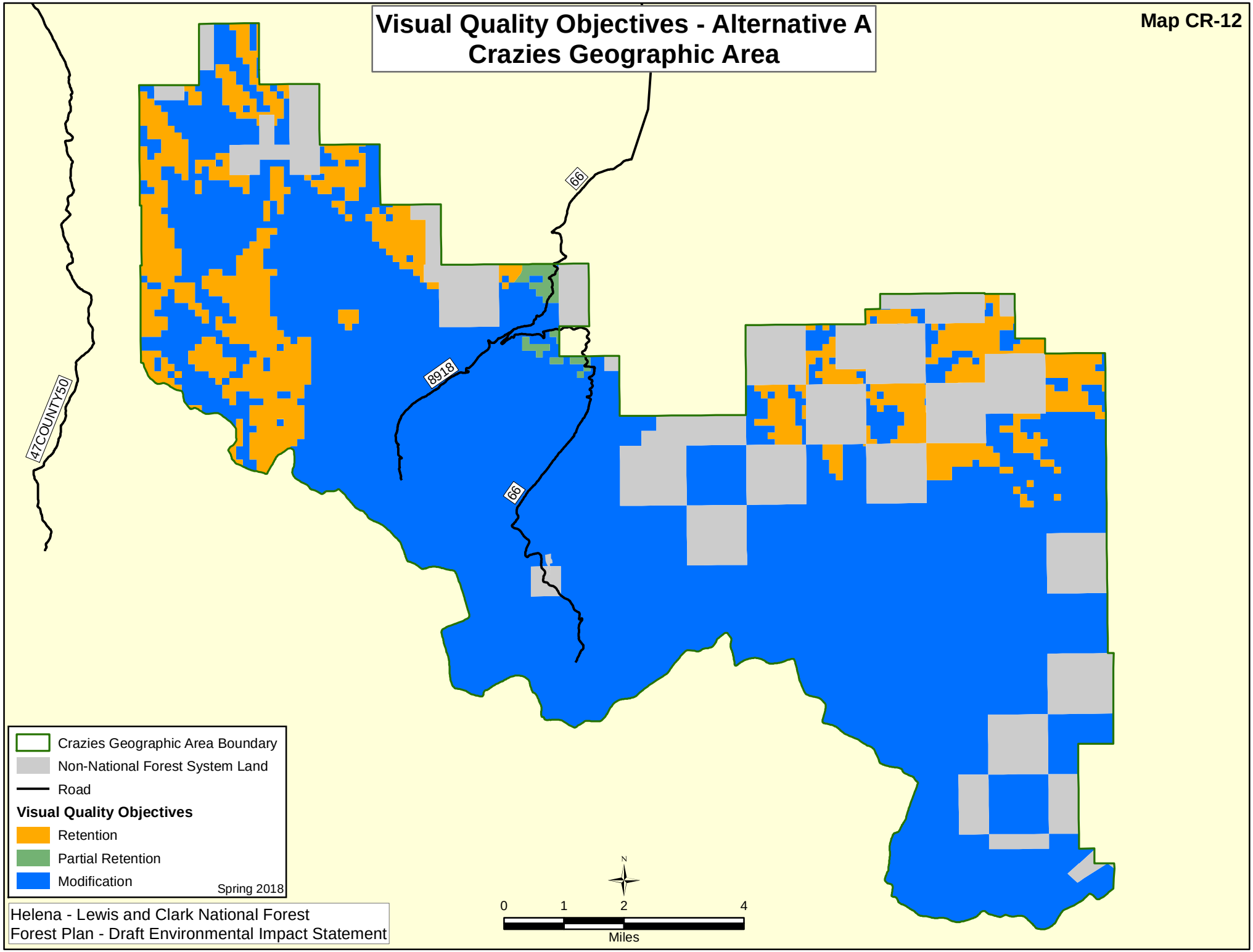
Map CR-11



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Visual Quality Objectives - Alternative A
Crazies Geographic Area

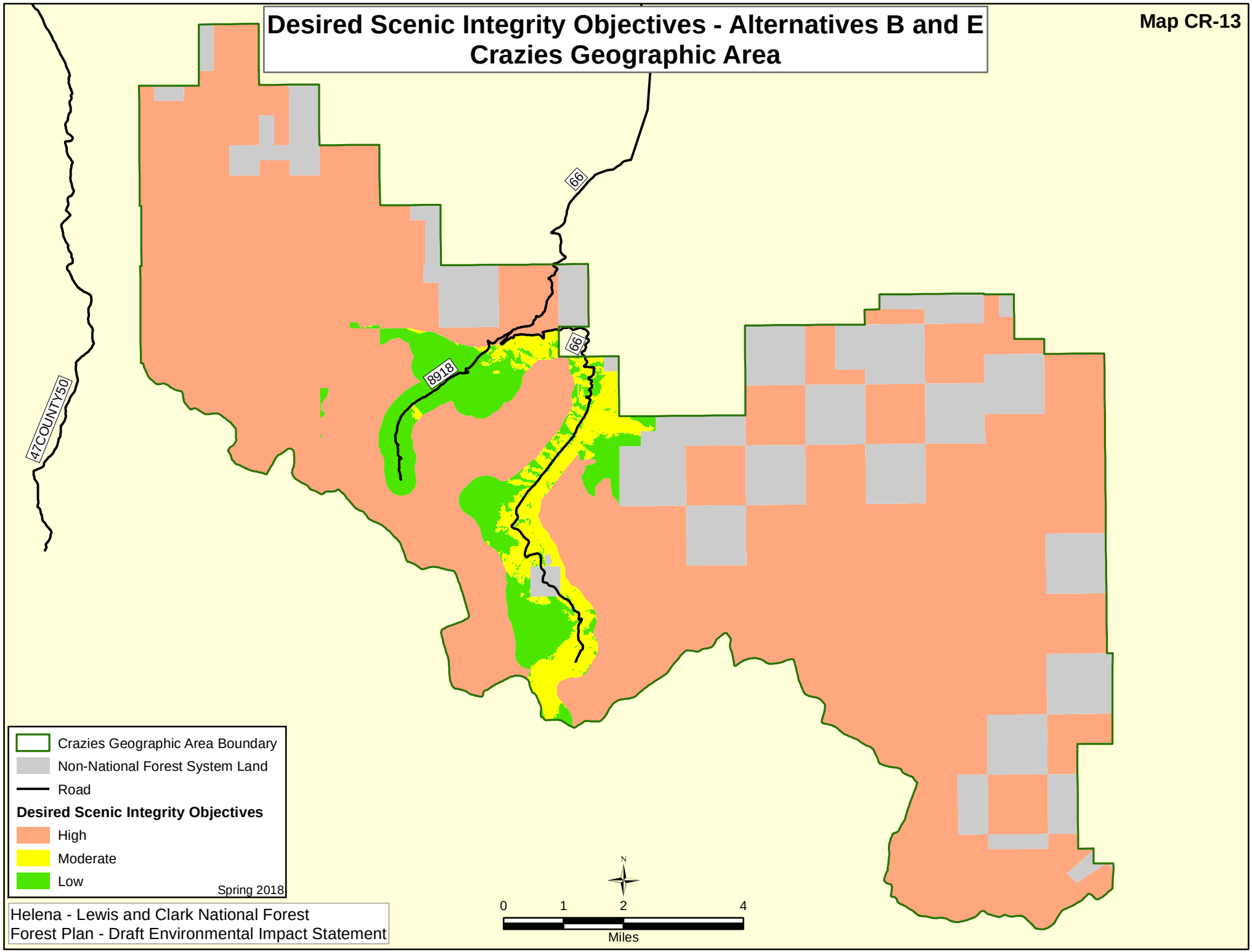
Map CR-12



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Desired Scenic Integrity Objectives - Alternatives B and E
Crazies Geographic Area

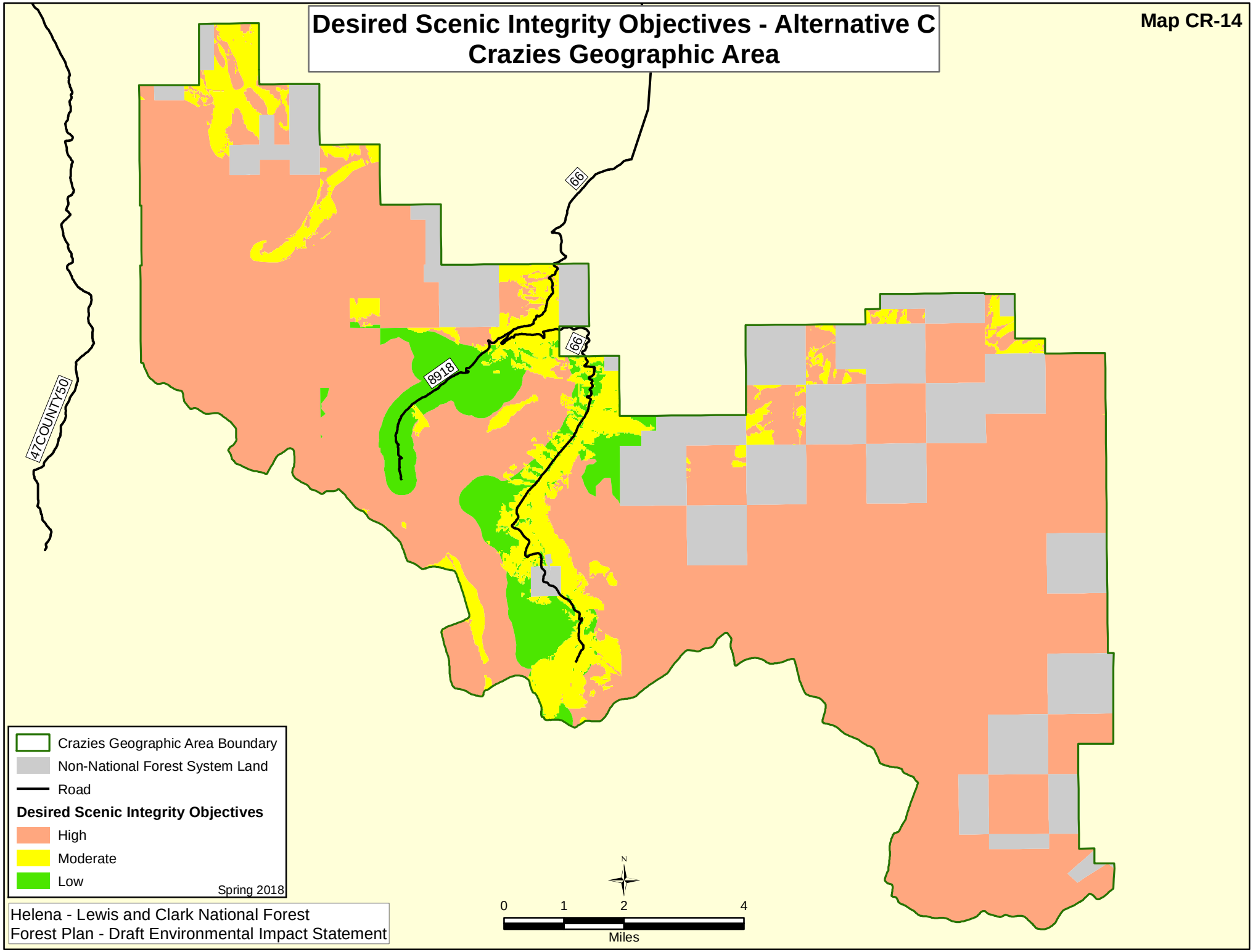
Map CR-13



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Desired Scenic Integrity Objectives - Alternative C
Crazies Geographic Area

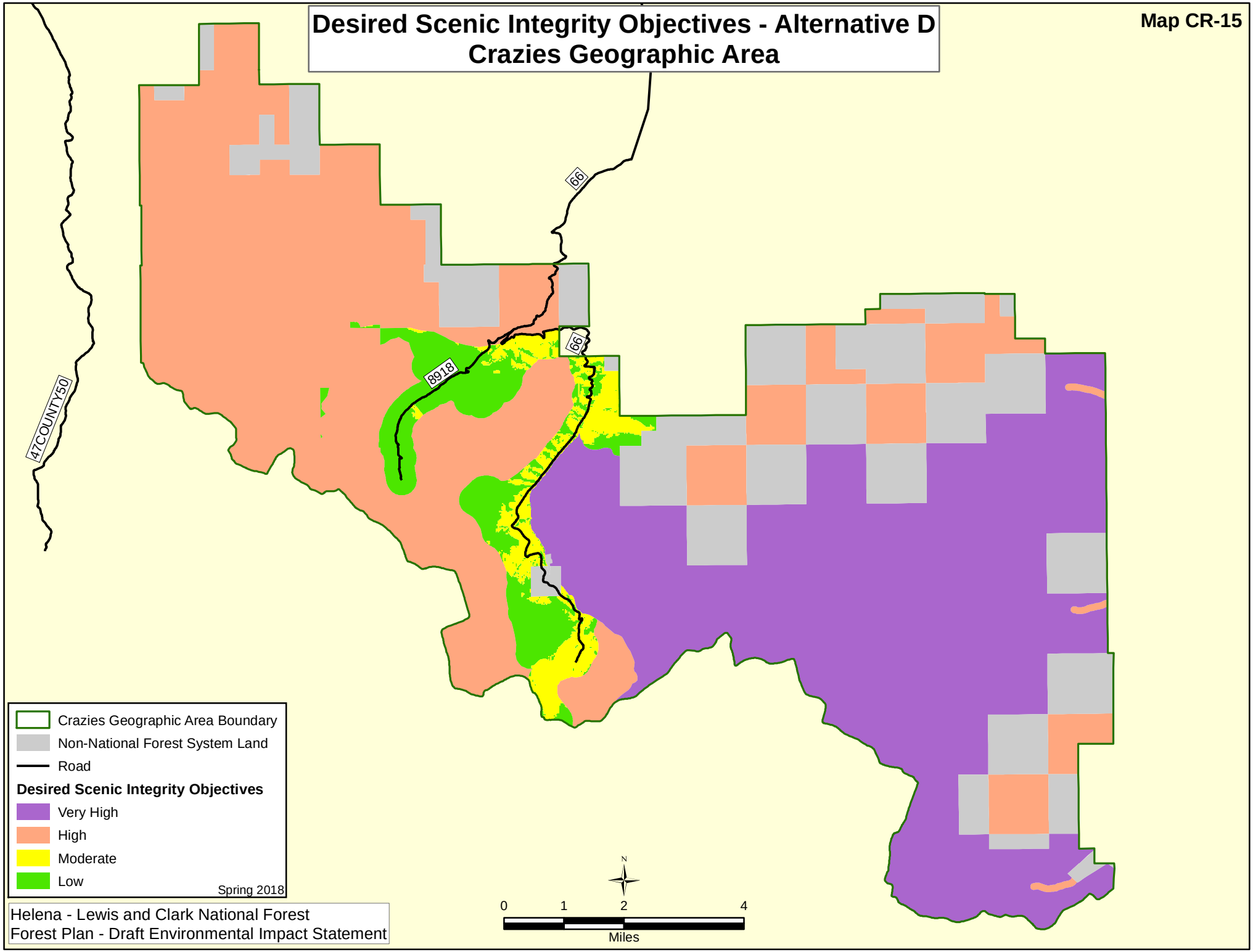
Map CR-14



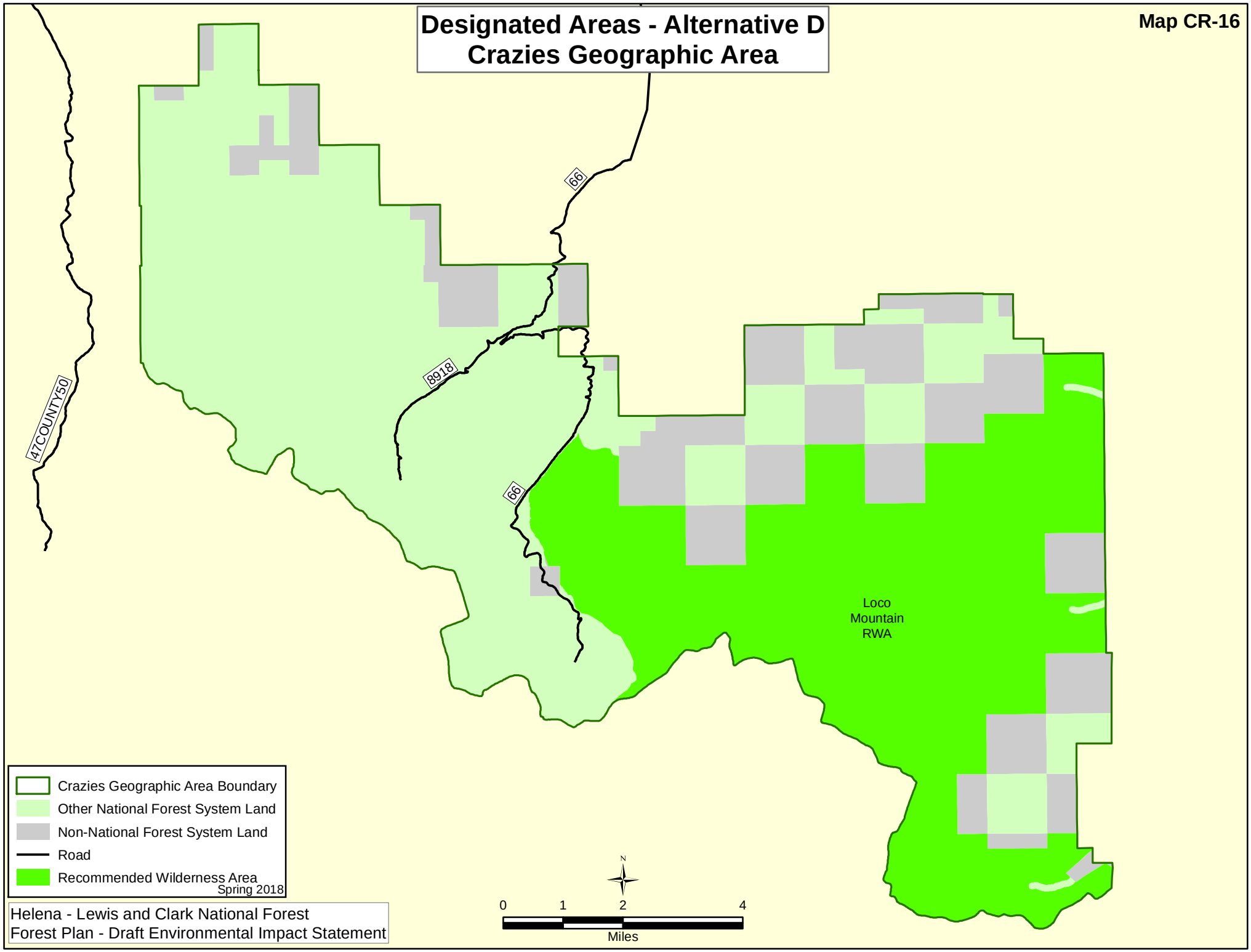
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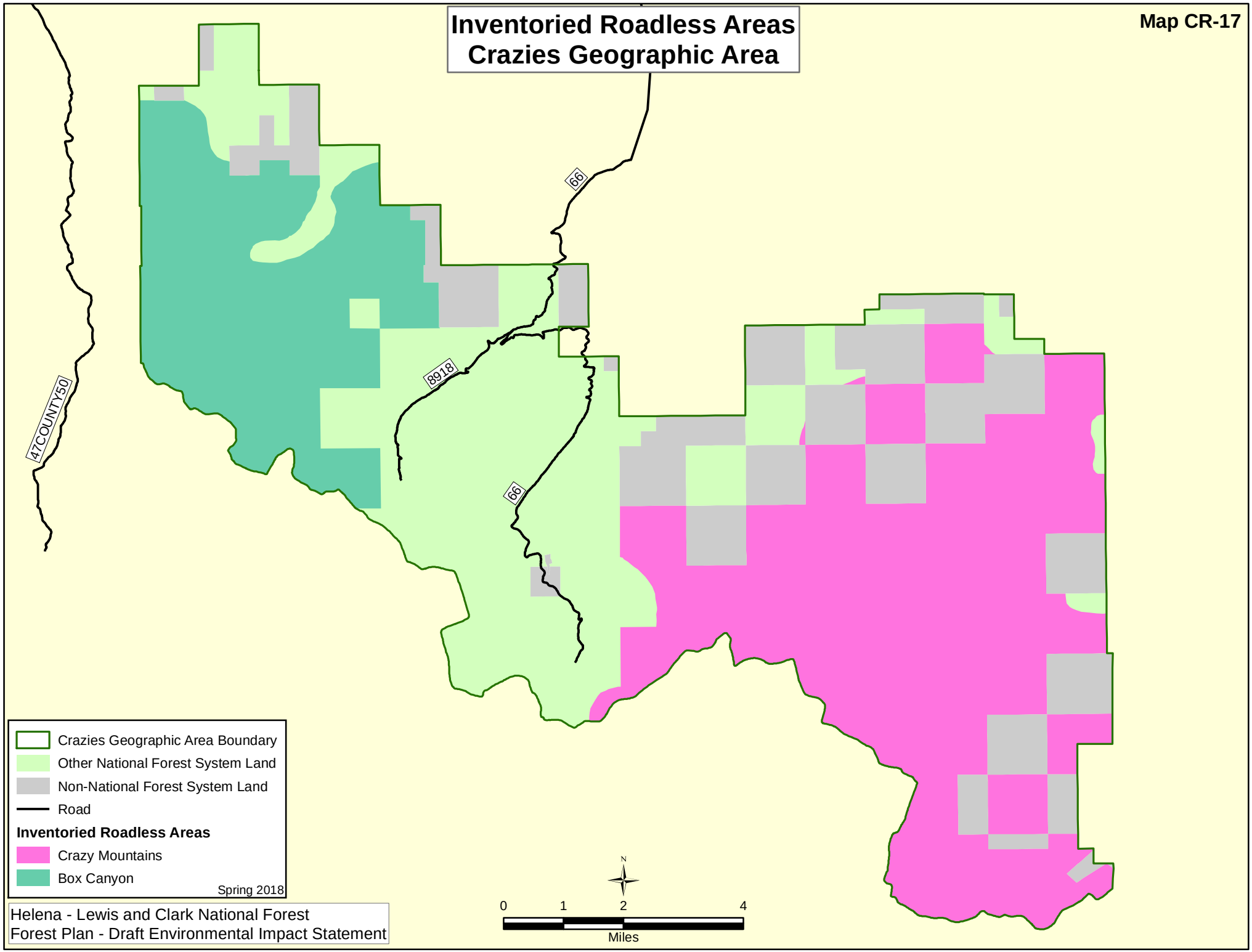
Desired Scenic Integrity Objectives - Alternative D
Crazies Geographic Area

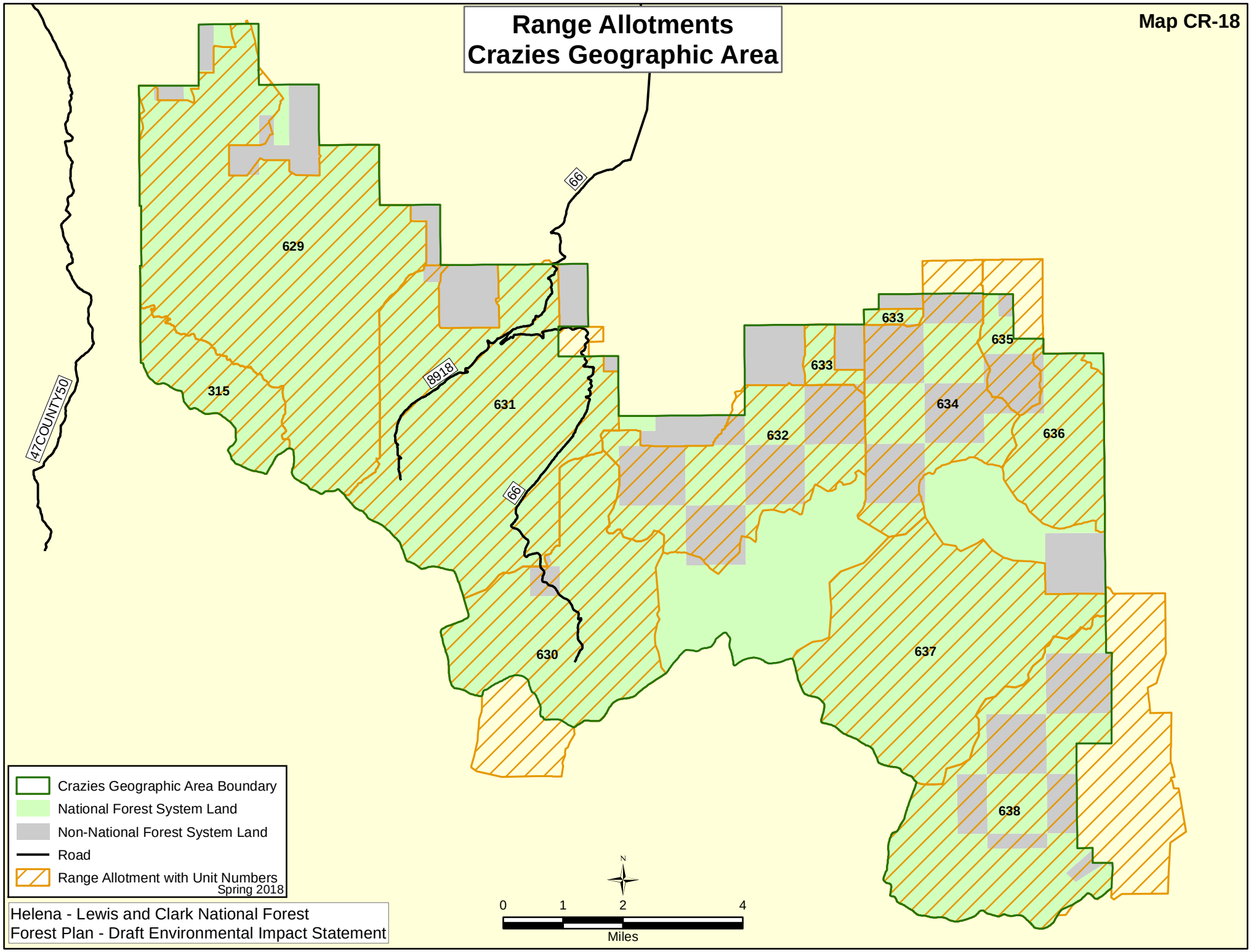
Map CR-15



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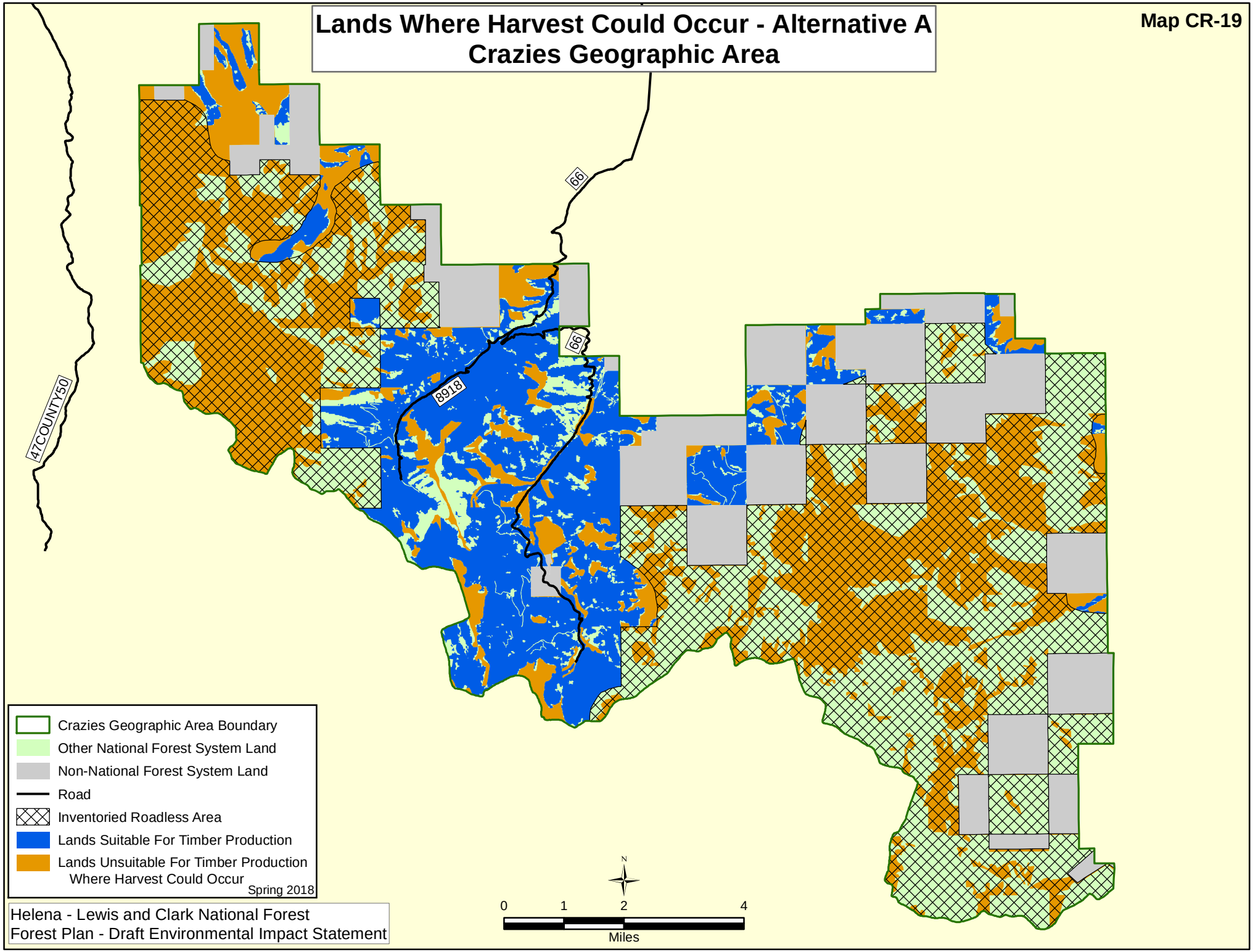

Designated Areas - Alternative D
Crazies Geographic Area
Map CR-16
66
8918
47COUNTY50
66
Loco
Mountain
RWA
Crazies Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Road
Recommended Wilderness Area
Spring 2018
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N
0
1
2
4
Miles


Inventoried Roadless Areas
Crazies Geographic Area
Map CR-17
66
8918
47COUNTY50
66
Crazies Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Road
Inventoried Roadless Areas
Crazy Mountains
Box Canyon
Spring 2018
N
0
1
2
4
Miles
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Range Allotments
Crazies Geographic Area
Map CR-18
629
315
631
630
632
633
633
634
635
636
637
638
66
66
8918
47COUNTY50
Crazies Geographic Area Boundary
National Forest System Land
Non-National Forest System Land
Road
Range Allotment with Unit Numbers
Spring 2018
N
0
1
2
4
Miles
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Lands Where Harvest Could Occur - Alternative A
Crazies Geographic Area

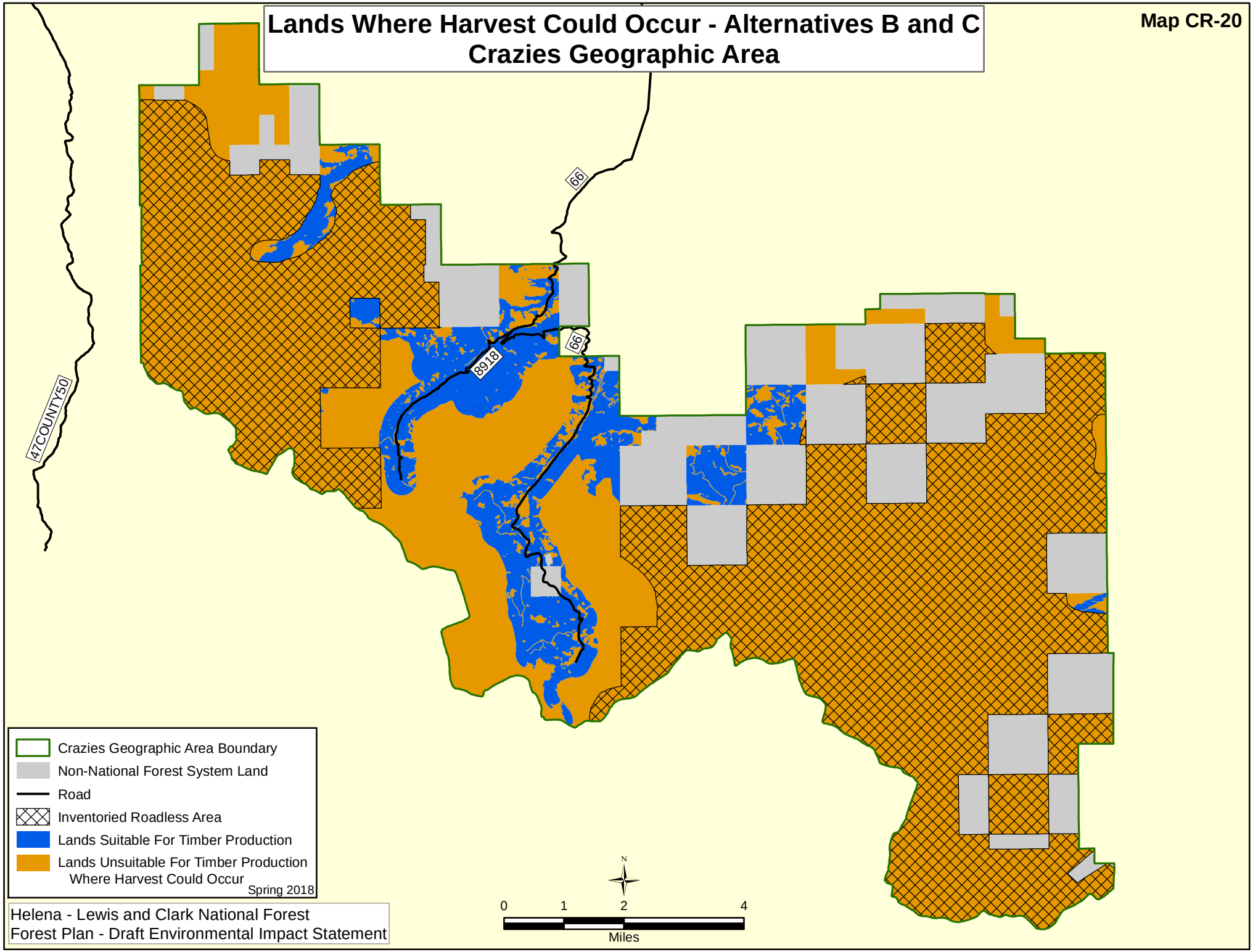
Map CR-19



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Lands Where Harvest Could Occur - Alternatives B and C
Crazies Geographic Area

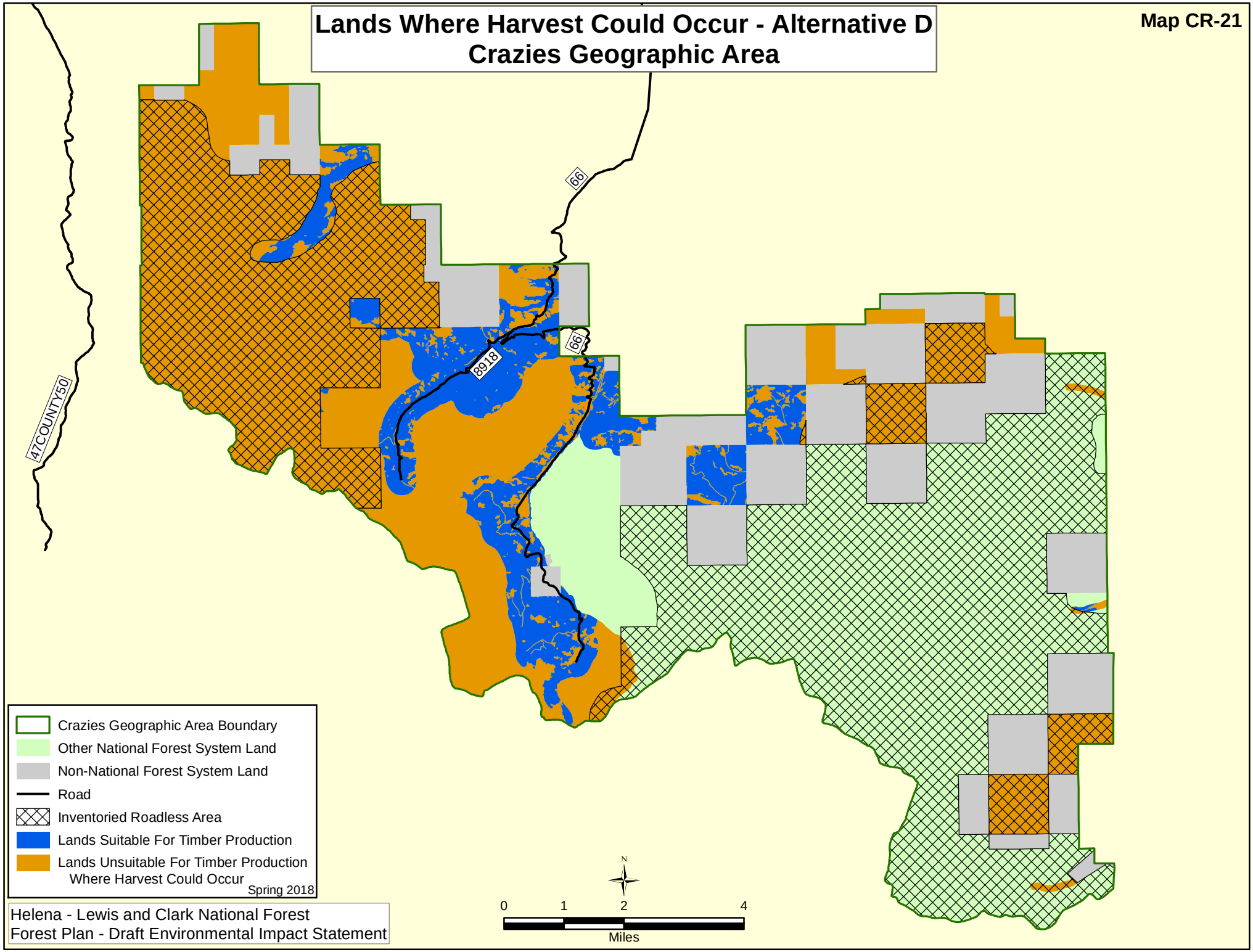
Map CR-20



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Lands Where Harvest Could Occur - Alternative D
Crazies Geographic Area

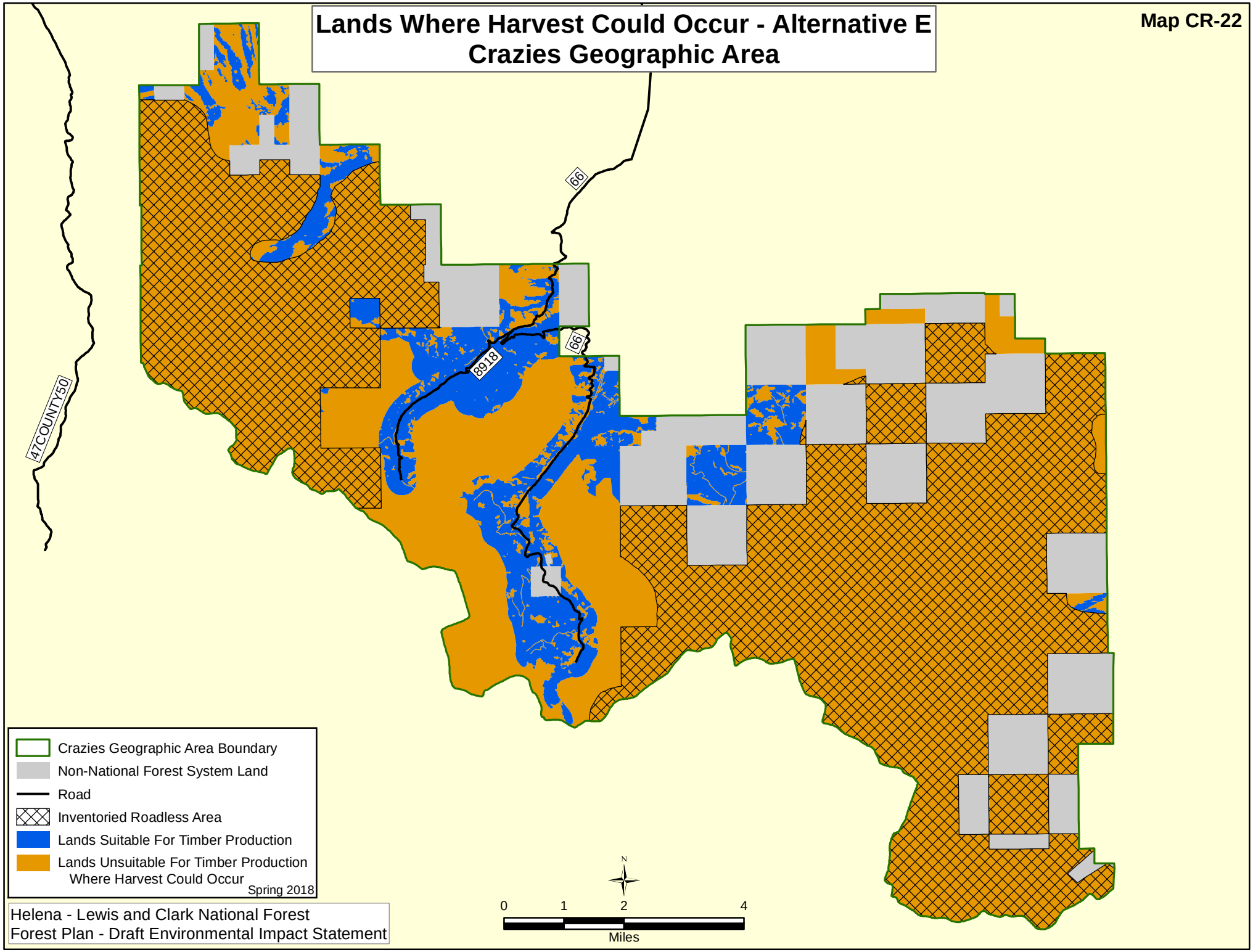
Map CR-21



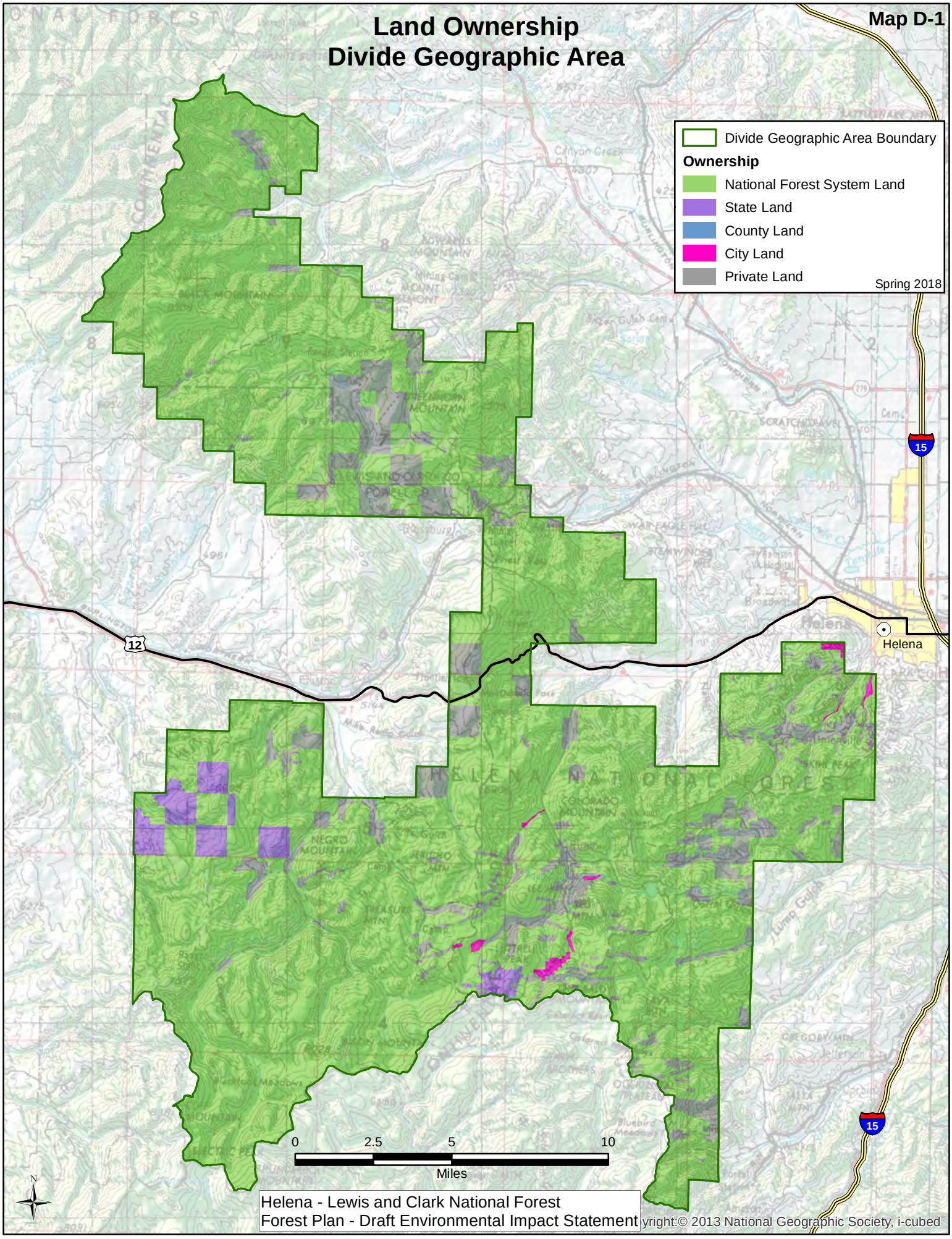
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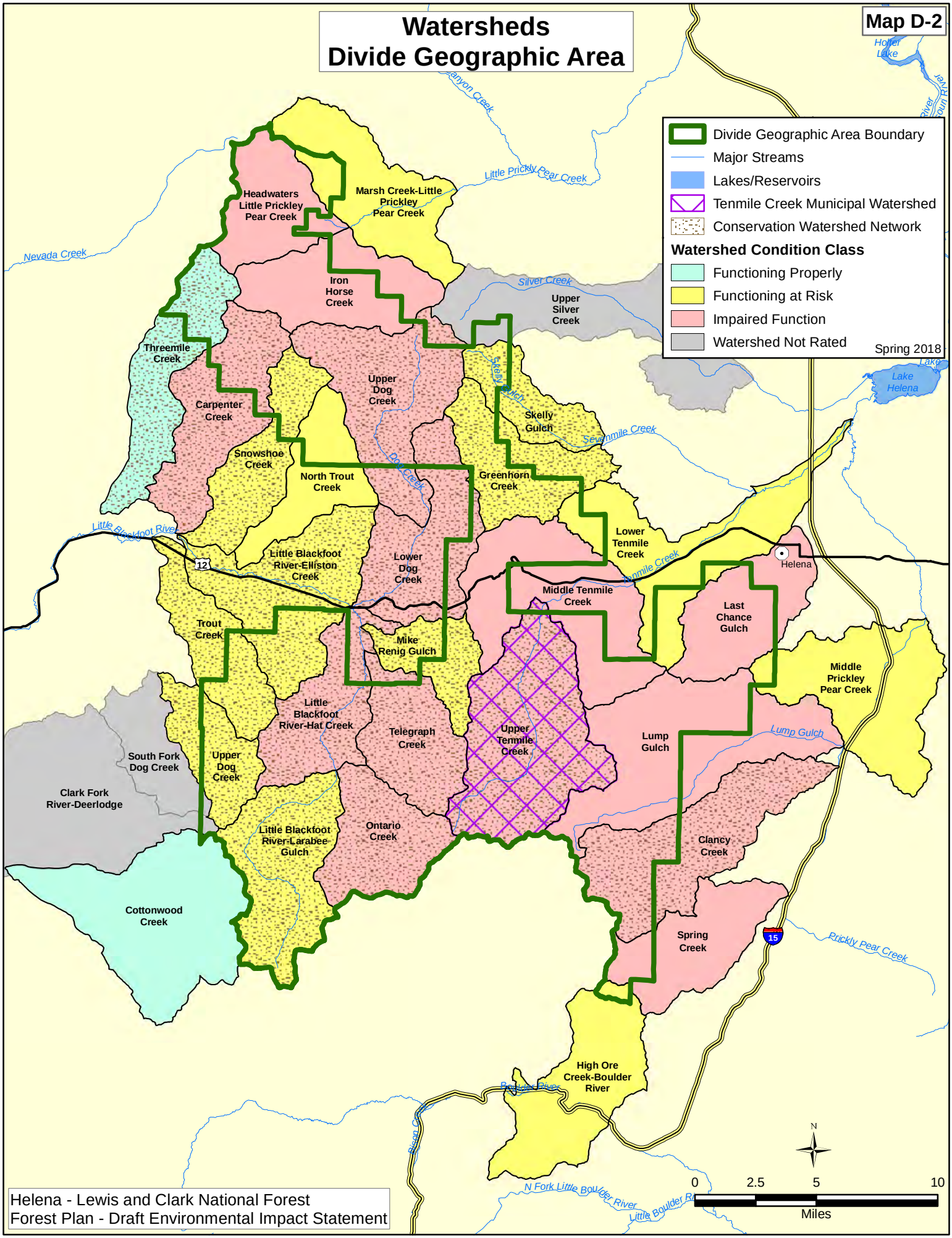
Lands Where Harvest Could Occur - Alternative E
Crazies Geographic Area

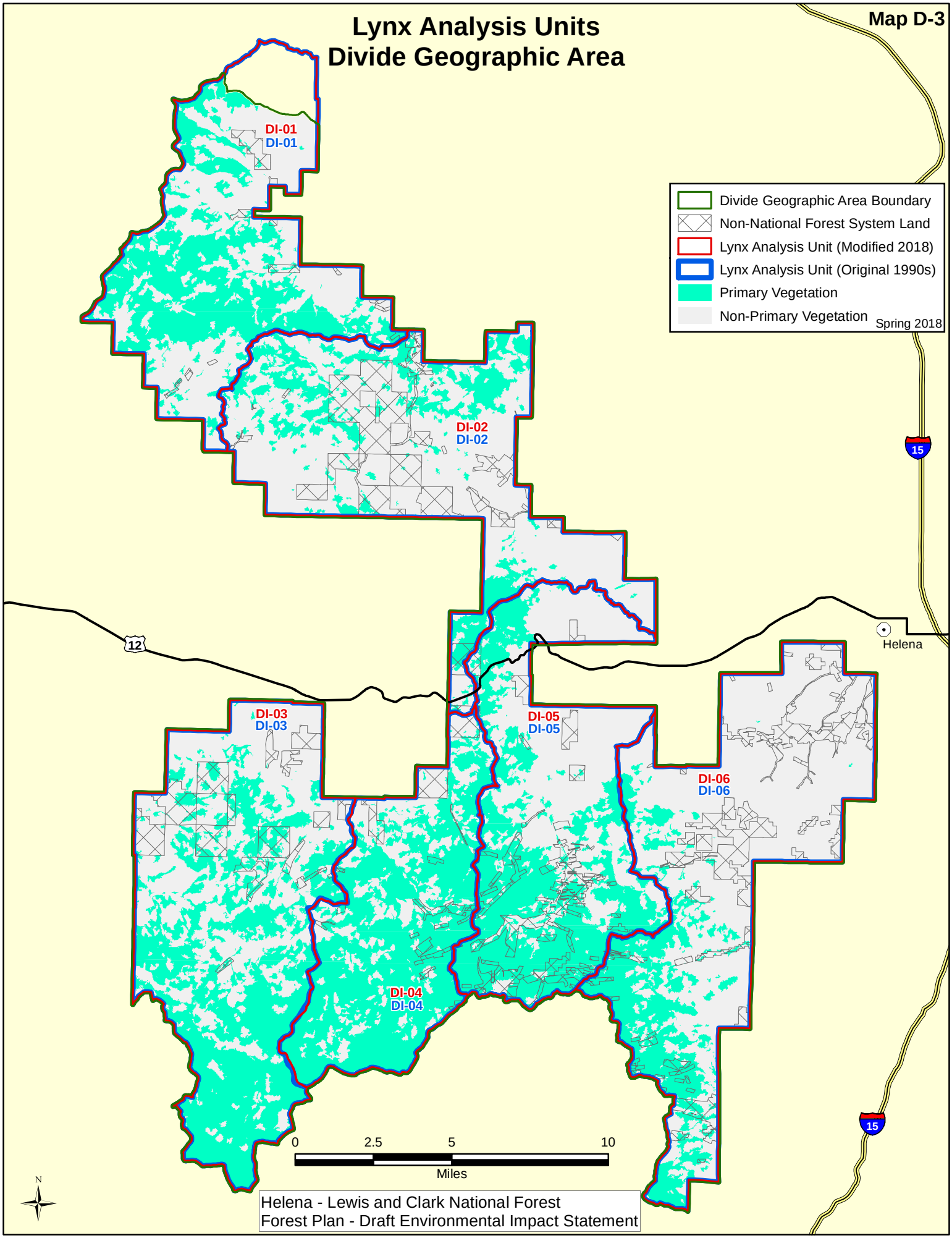
Map CR-22



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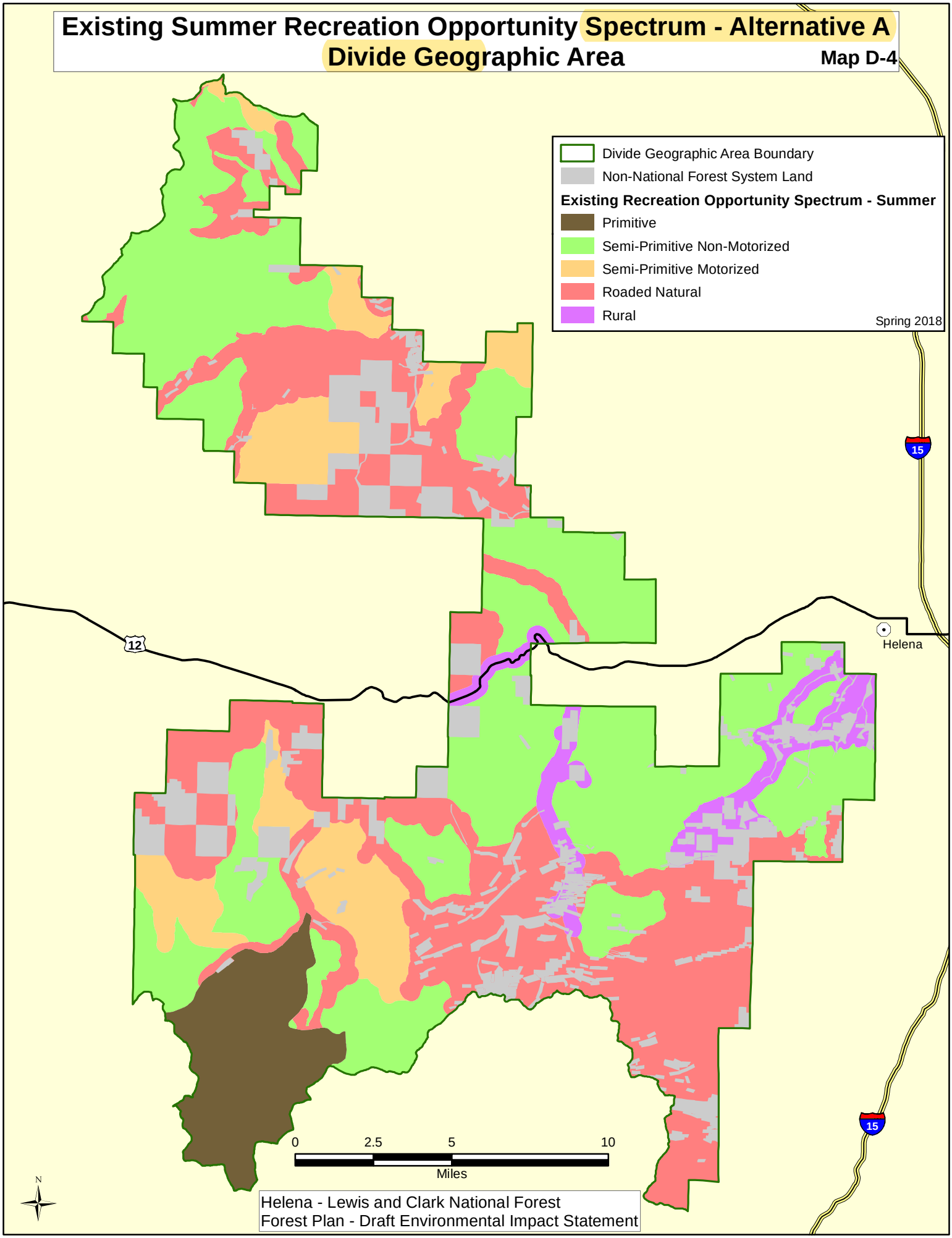

Land Ownership
Divide Geographic Area
Map D-1
Divide Geographic Area Boundary
Ownership
National Forest System Land
State Land
County Land
City Land
Private Land
Spring 2018
Helena
12
15
15
HELENA NATIONAL FOREST
0
2.5
5
10
Miles
N
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Watersheds
Divide Geographic Area
Map D-2
Divide Geographic Area Boundary
Major Streams
Lakes/Reservoirs
Tenmile Creek Municipal Watershed
Conservation Watershed Network
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018
Headwaters Little Prickley Pear Creek
Marsh Creek-Little Prickley Pear Creek
Iron Horse Creek
Upper Silver Creek
Threemile Creek
Carpenter Creek
Upper Dog Creek
Skelly Gulch
Snowshoe Creek
North Trout Creek
Greenhorn Creek
Lower Tenmile Creek
Little Blackfoot River-Elliston Creek
Lower Dog Creek
Middle Tenmile Creek
Last Chance Gulch
Trout Creek
Mike Renig Gulch
Middle Prickley Pear Creek
Little Blackfoot River-Hat Creek
Telegraph Creek
Upper Tenmile Creek
Lump Gulch
South Fork Dog Creek
Upper Dog Creek
Clark Fork River-Deerlodge
Little Blackfoot River-Larabee Gulch
Ontario Creek
Clancy Creek
Cottonwood Creek
Spring Creek
High Ore Creek-Boulder River
Little Prickly Pear Creek
Nevada Creek
Silver Creek
Lake Helena
Sevenmile Creek
Dog Creek
Little Blackfoot River
Tenmile Creek
Prickly Pear Creek
N Fork Little Boulder River
Little Boulder River
Helena
12
15
N
0
2.5
5
10
Miles
Helena - Lewis and Clark National Forest
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Map D-3
Lynx Analysis Units
Divide Geographic Area
DI-01
DI-01
DI-02
DI-02
DI-03
DI-03
DI-04
DI-04
DI-05
DI-05
DI-06
DI-06
Divide Geographic Area Boundary
Non-National Forest System Land
Lynx Analysis Unit (Modified 2018)
Lynx Analysis Unit (Original 1990s)
Primary Vegetation
Non-Primary Vegetation
Spring 2018
12
15
Helena
0
2.5
5
10
Miles
N
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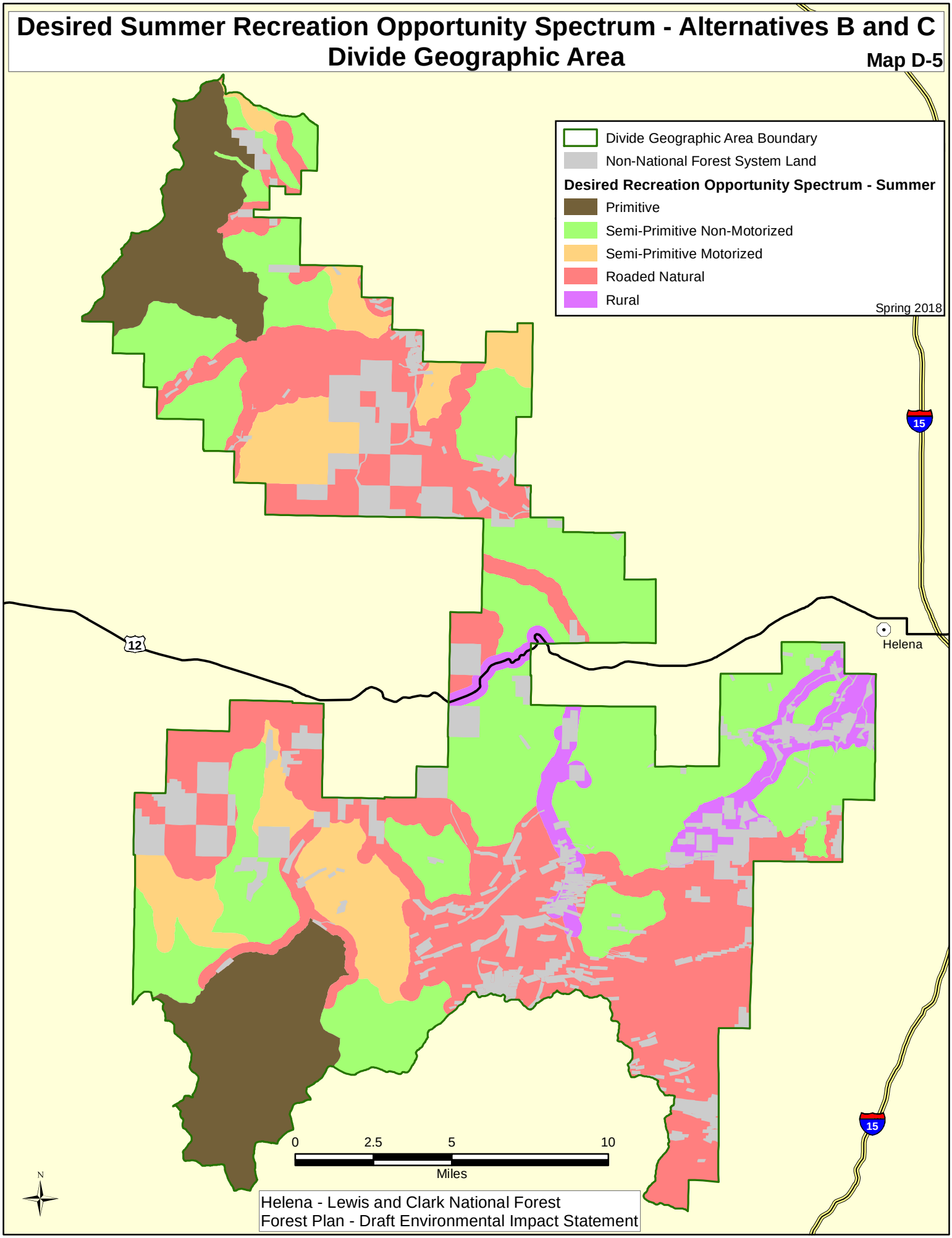
Existing Summer Recreation Opportunity Spectrum - Alternative A
Divide Geographic Area

Map D-4



Desired Summer Recreation Opportunity Spectrum - Alternatives B and C
Divide Geographic Area

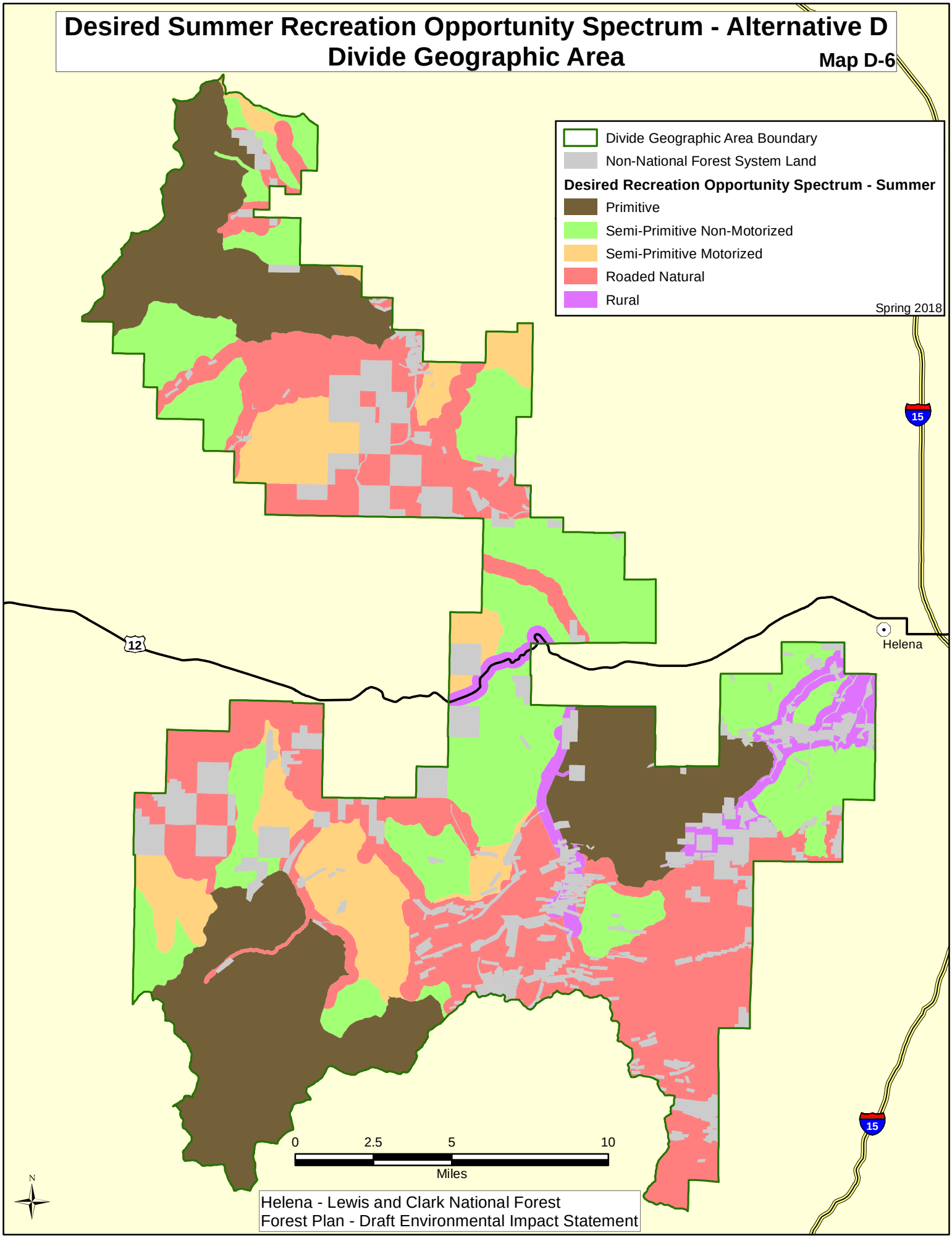
Map D-5



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Divide Geographic Area

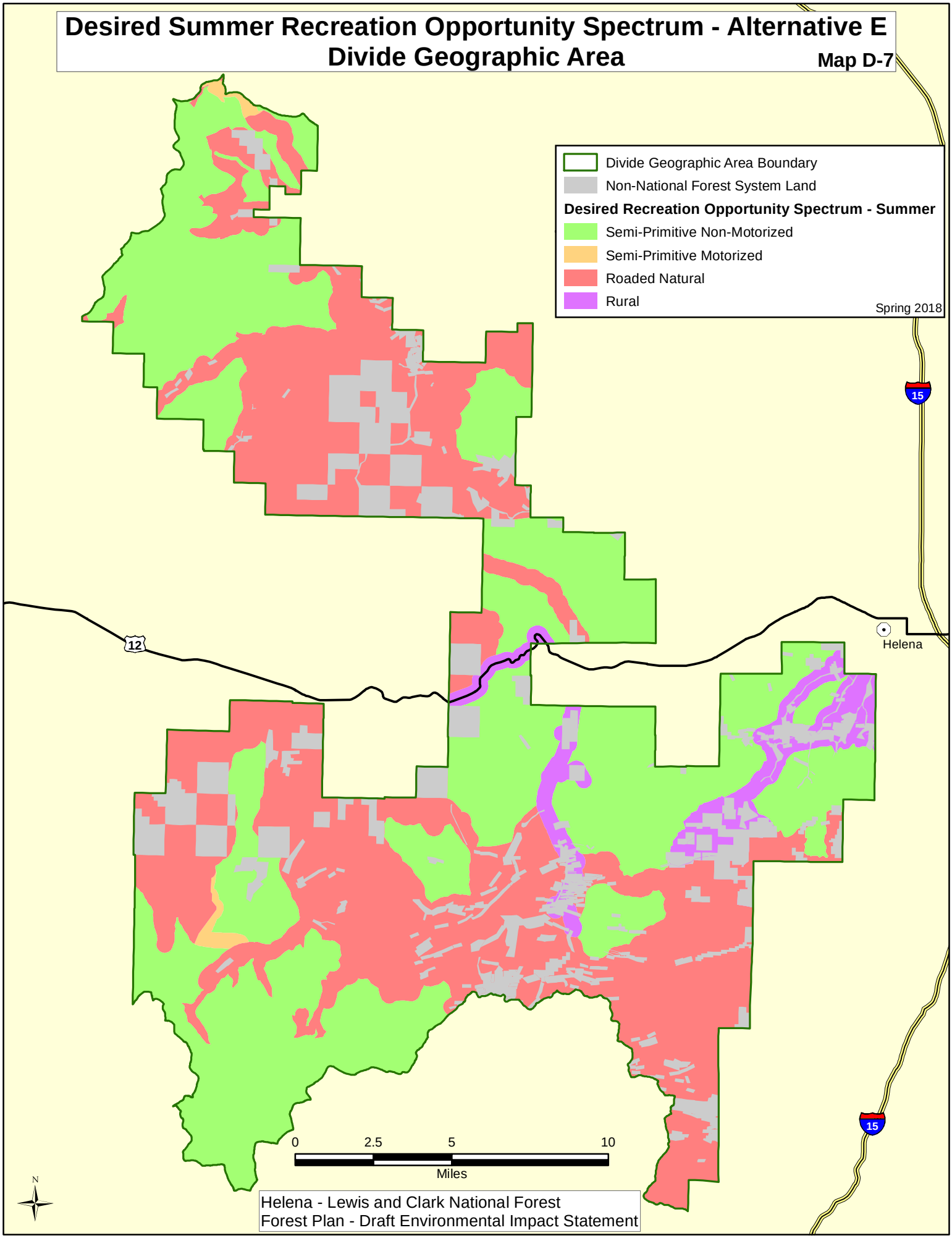
Map D-6



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Desired Summer Recreation Opportunity Spectrum - Alternative E
Divide Geographic Area

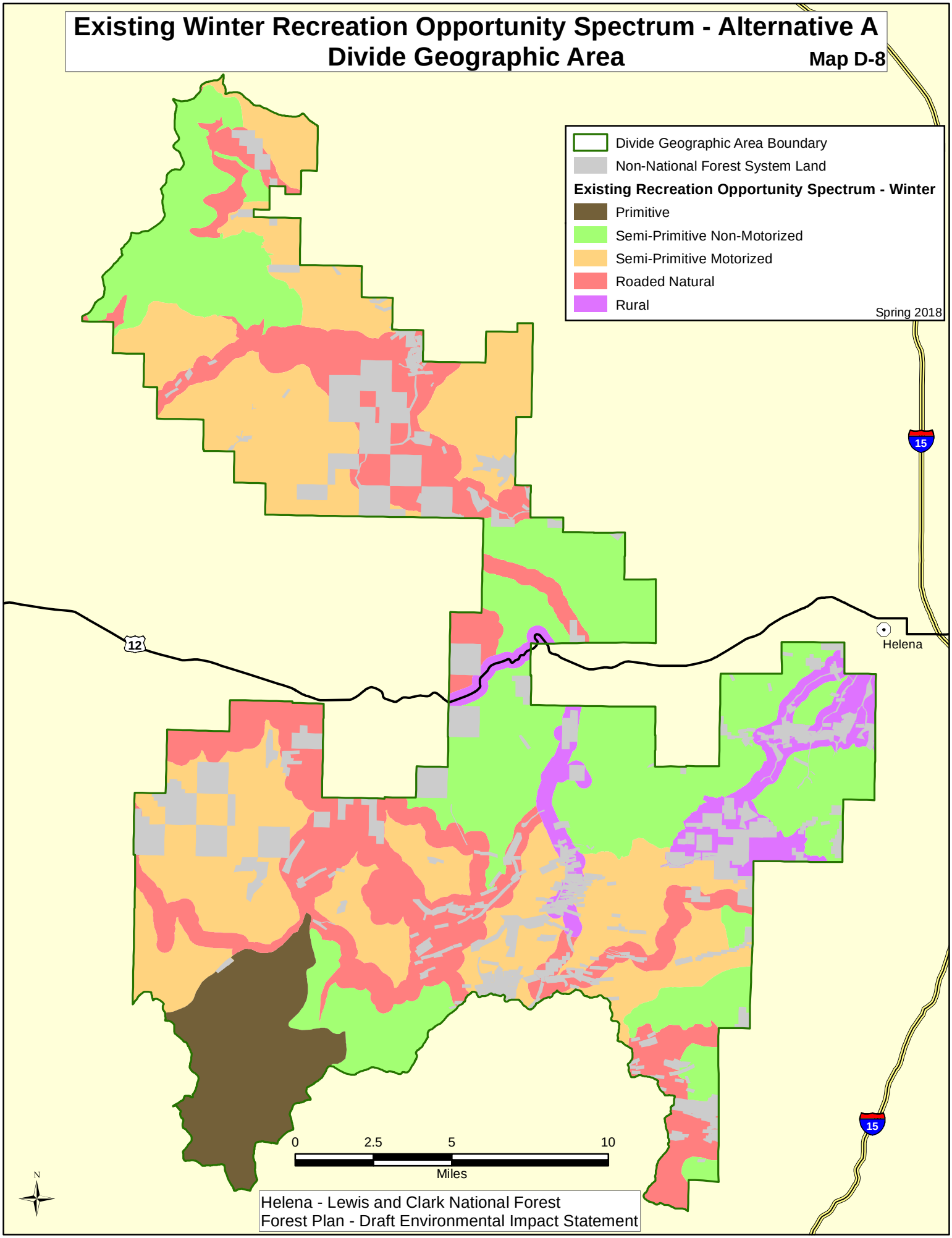
Map D-7



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Divide Geographic Area

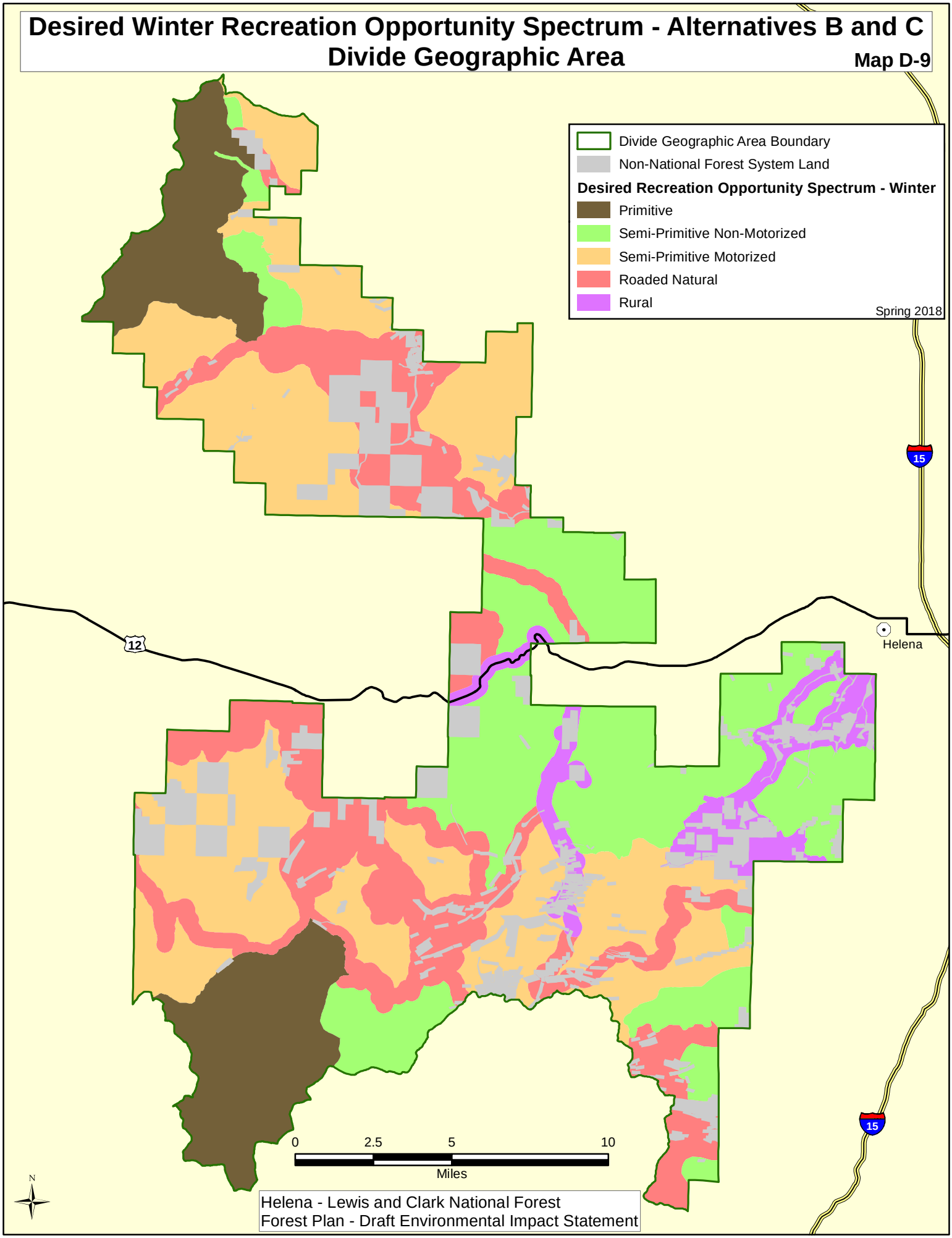
Map D-8



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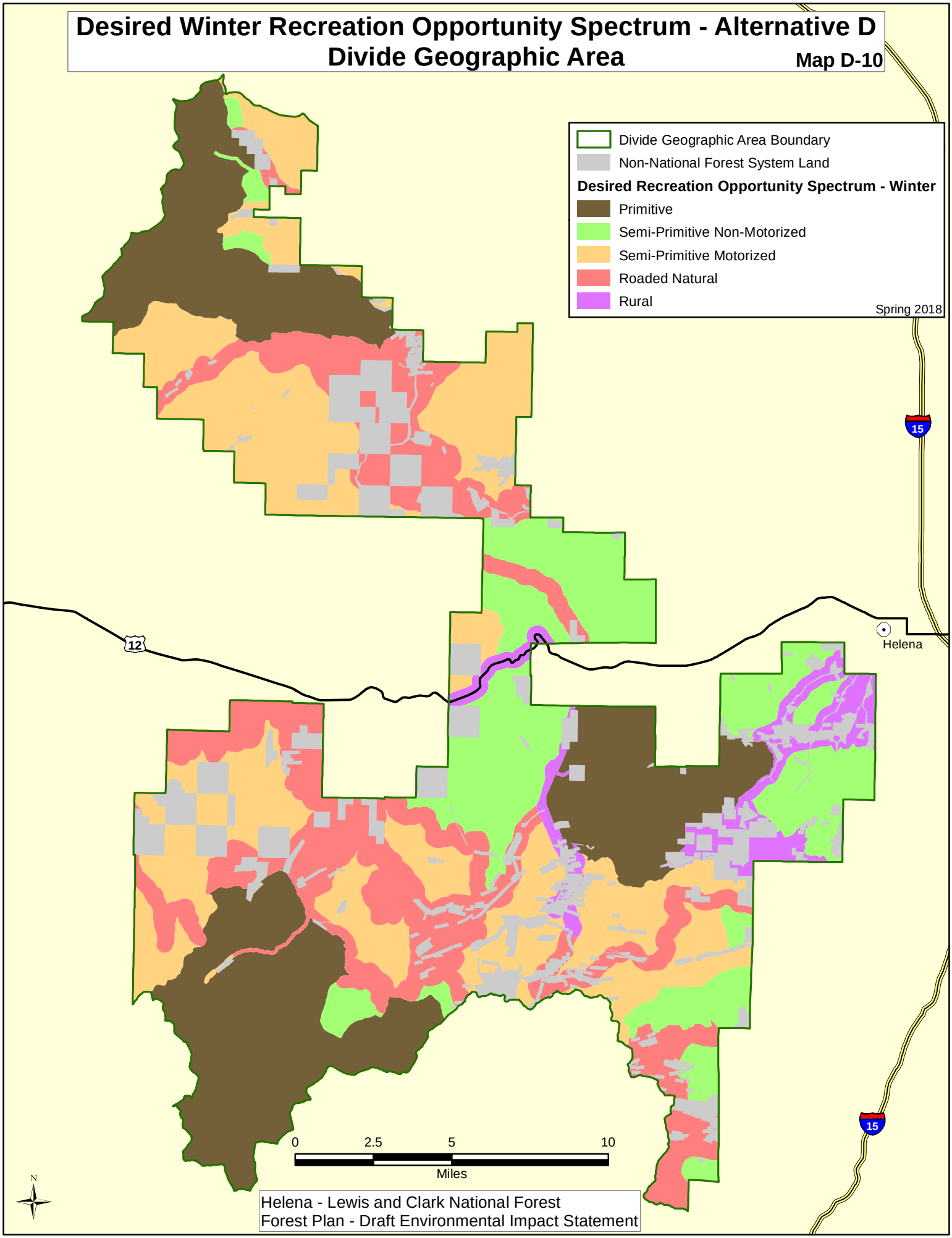
Desired Winter Recreation Opportunity Spectrum - Alternatives B and C
Divide Geographic Area

Map D-9



Desired Winter Recreation Opportunity Spectrum - Alternative D
Divide Geographic Area

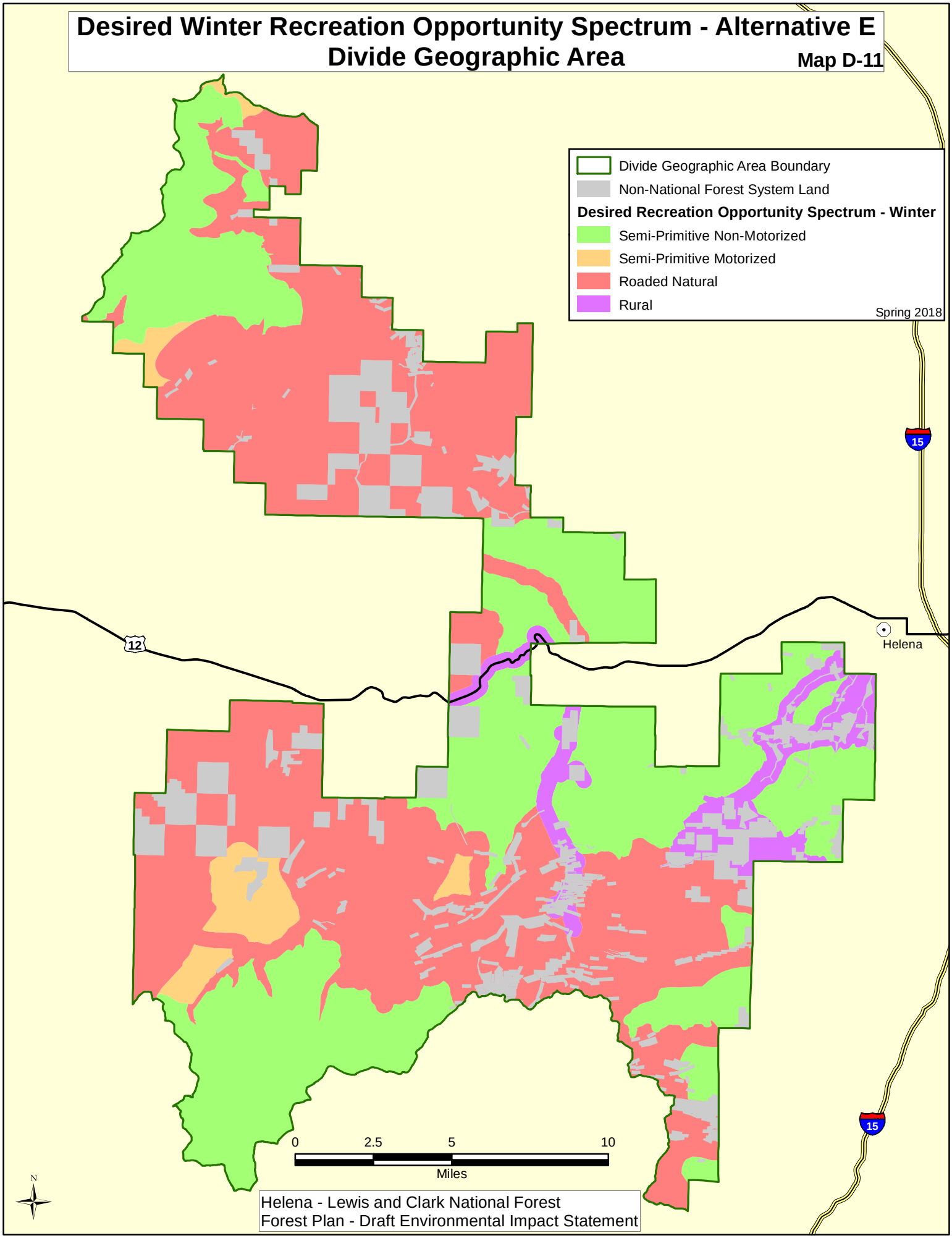
Map D-10



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Desired Winter Recreation Opportunity Spectrum - Alternative E
Divide Geographic Area

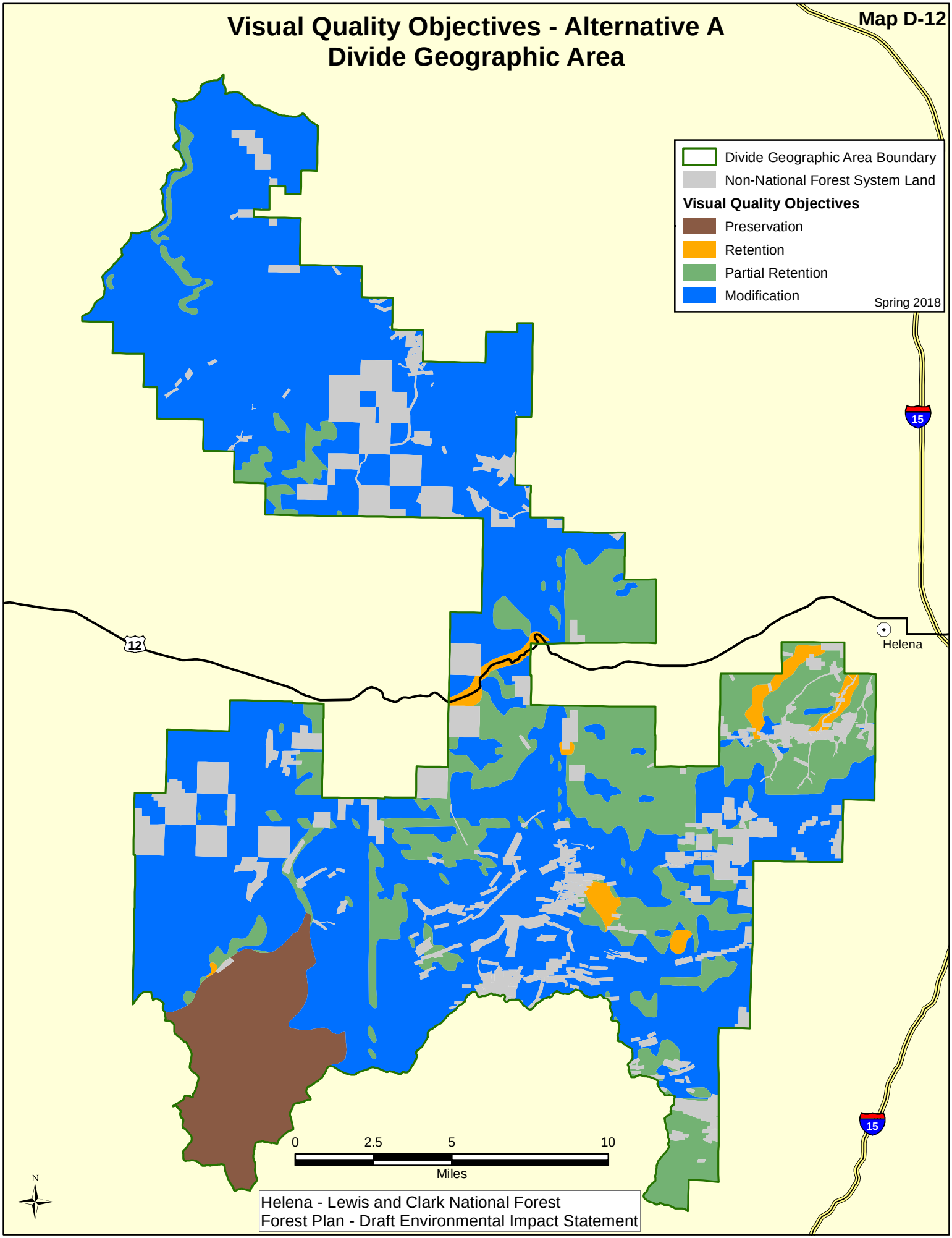
Map D-11



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Visual Quality Objectives - Alternative A
Divide Geographic Area

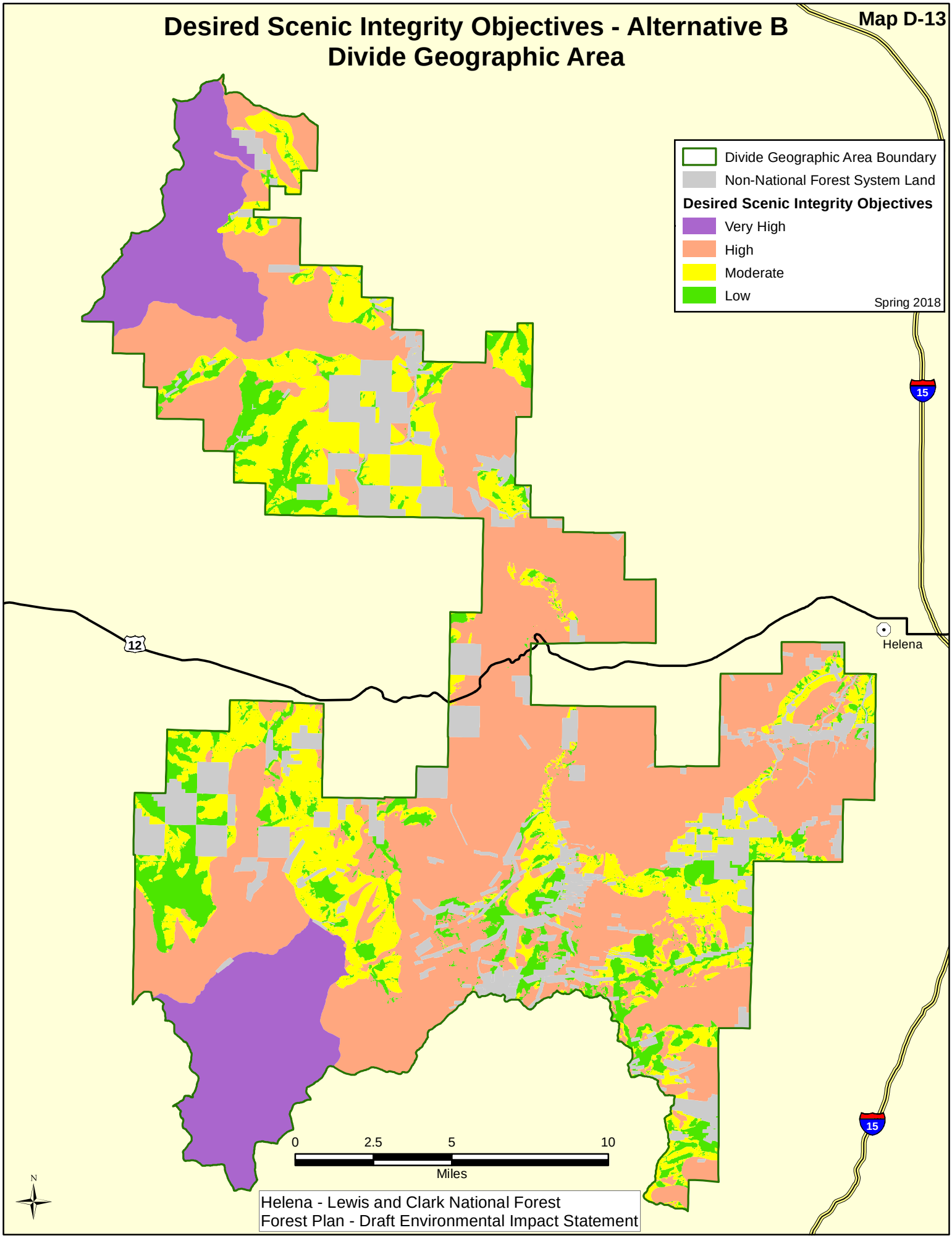
Map D-12



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Desired Scenic Integrity Objectives - Alternative B
Divide Geographic Area

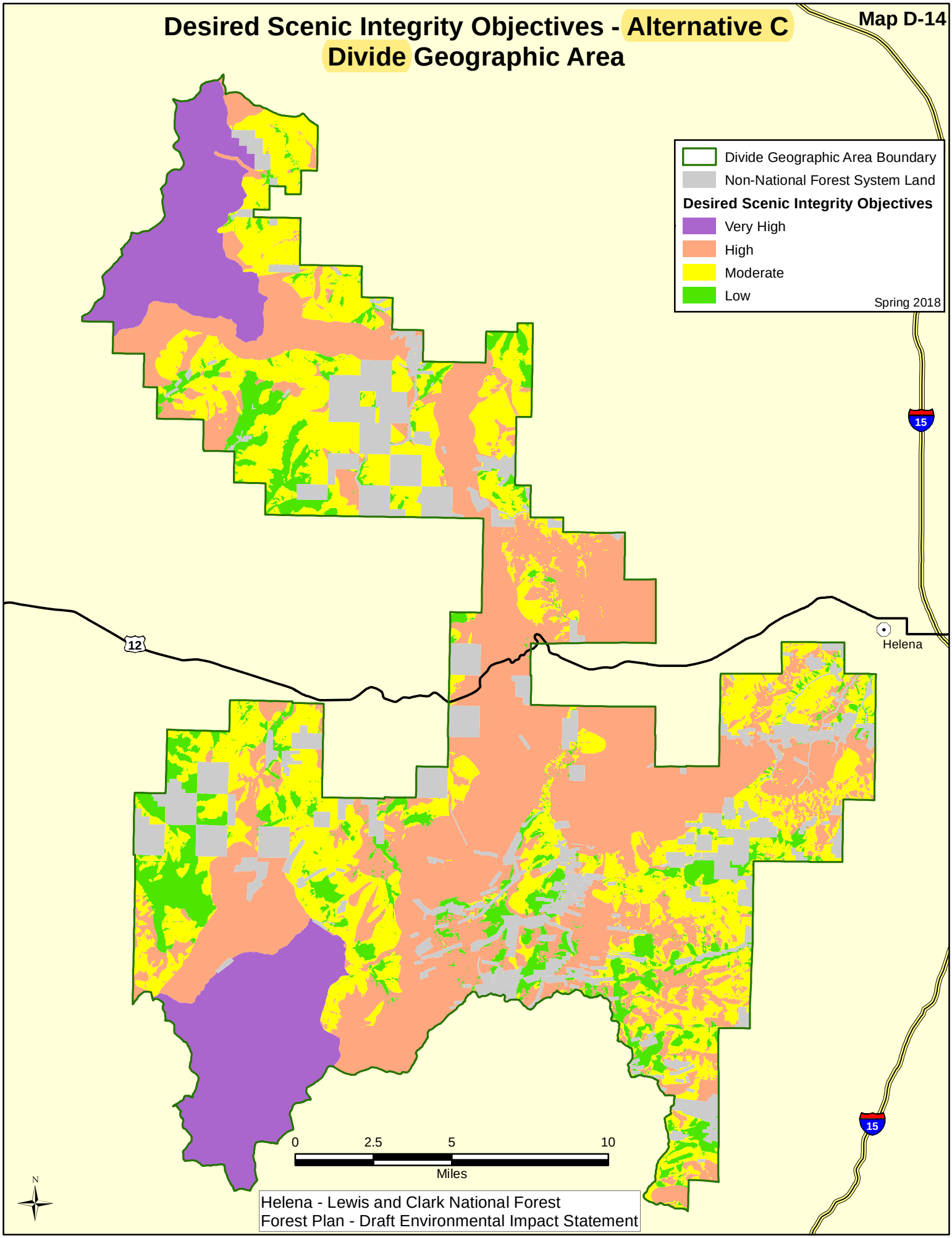
Map D-13



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Desired Scenic Integrity Objectives - Alternative C
Divide Geographic Area

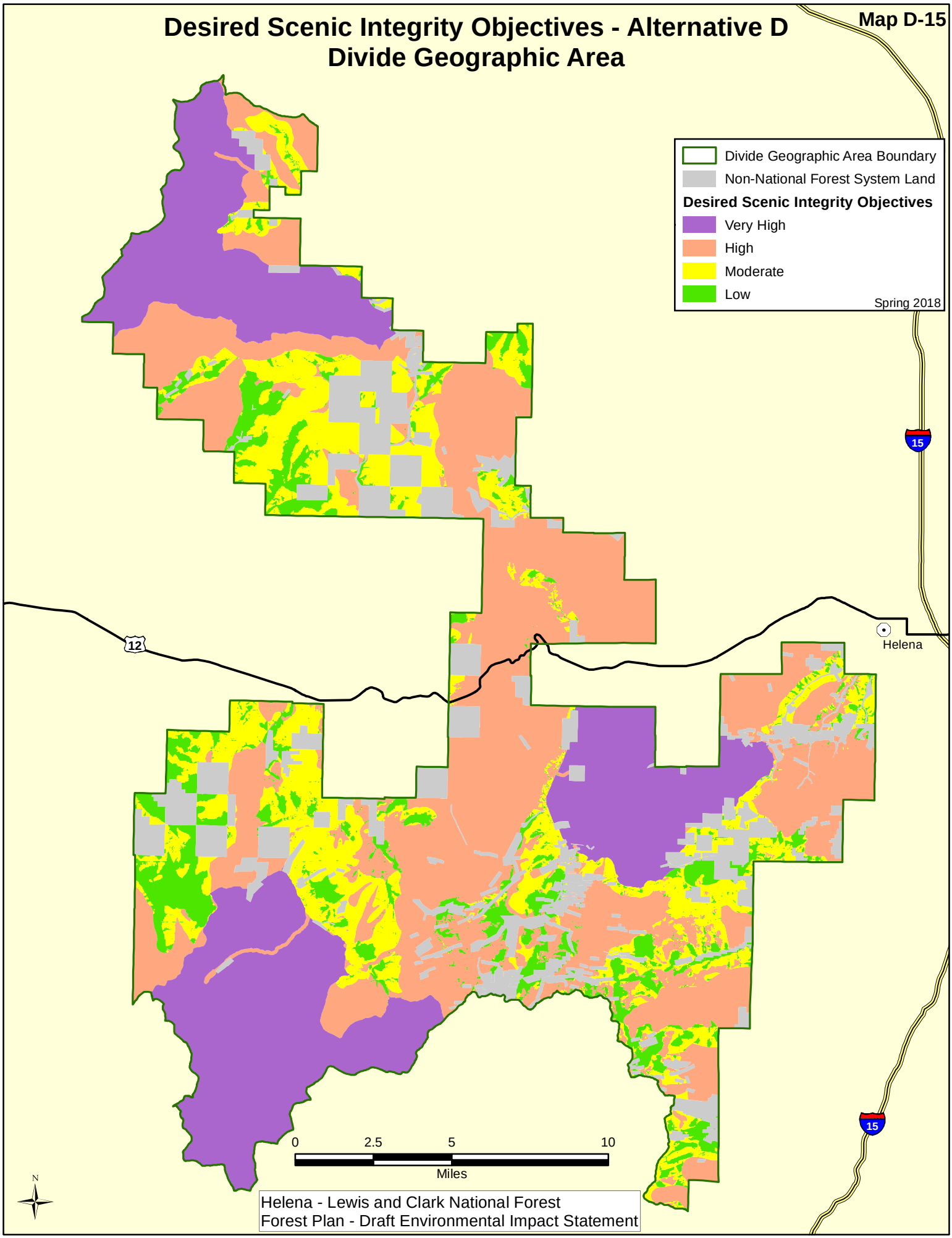
Map D-14



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Desired Scenic Integrity Objectives - Alternative D
Divide Geographic Area

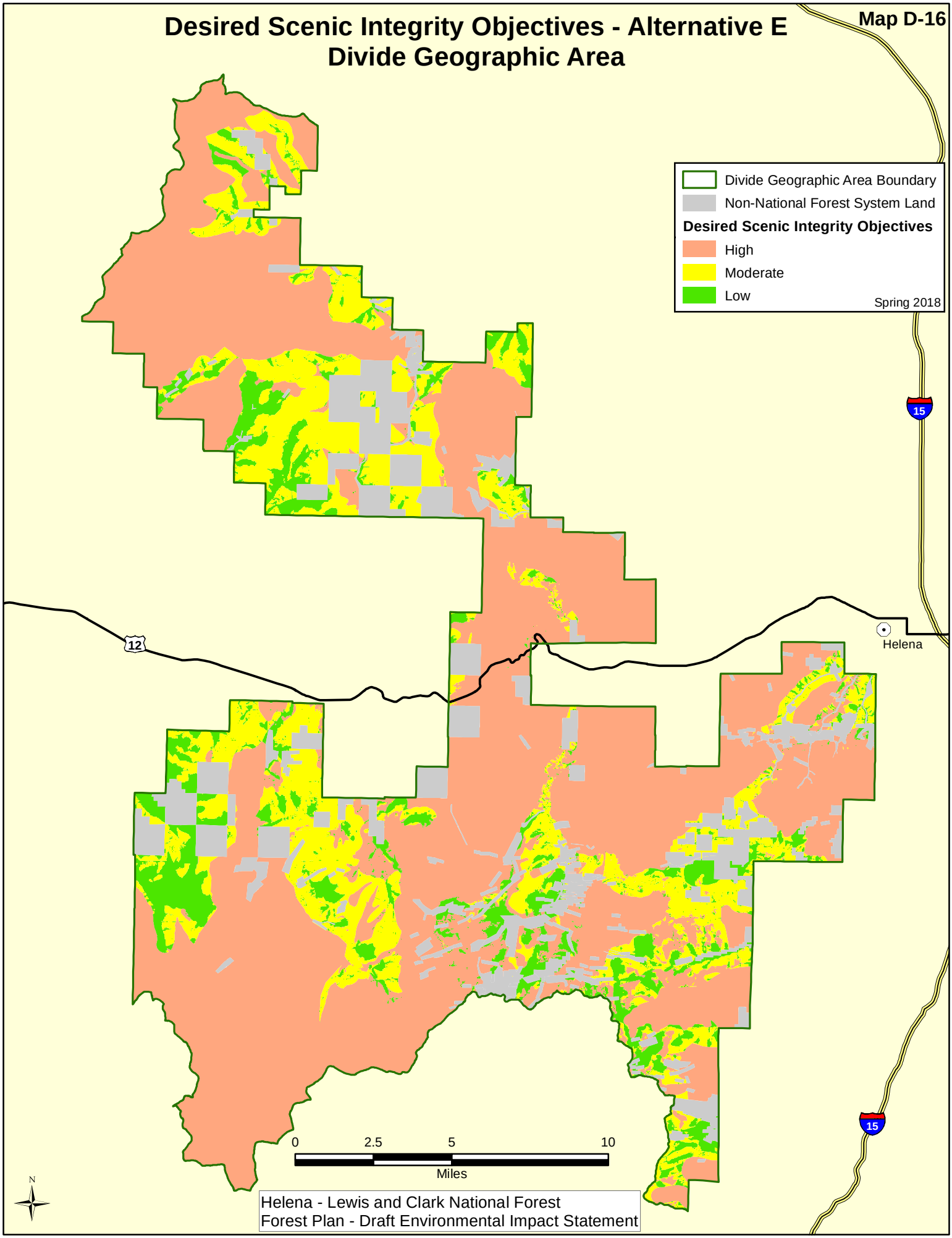
Map D-15



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Desired Scenic Integrity Objectives - Alternative E
Divide Geographic Area

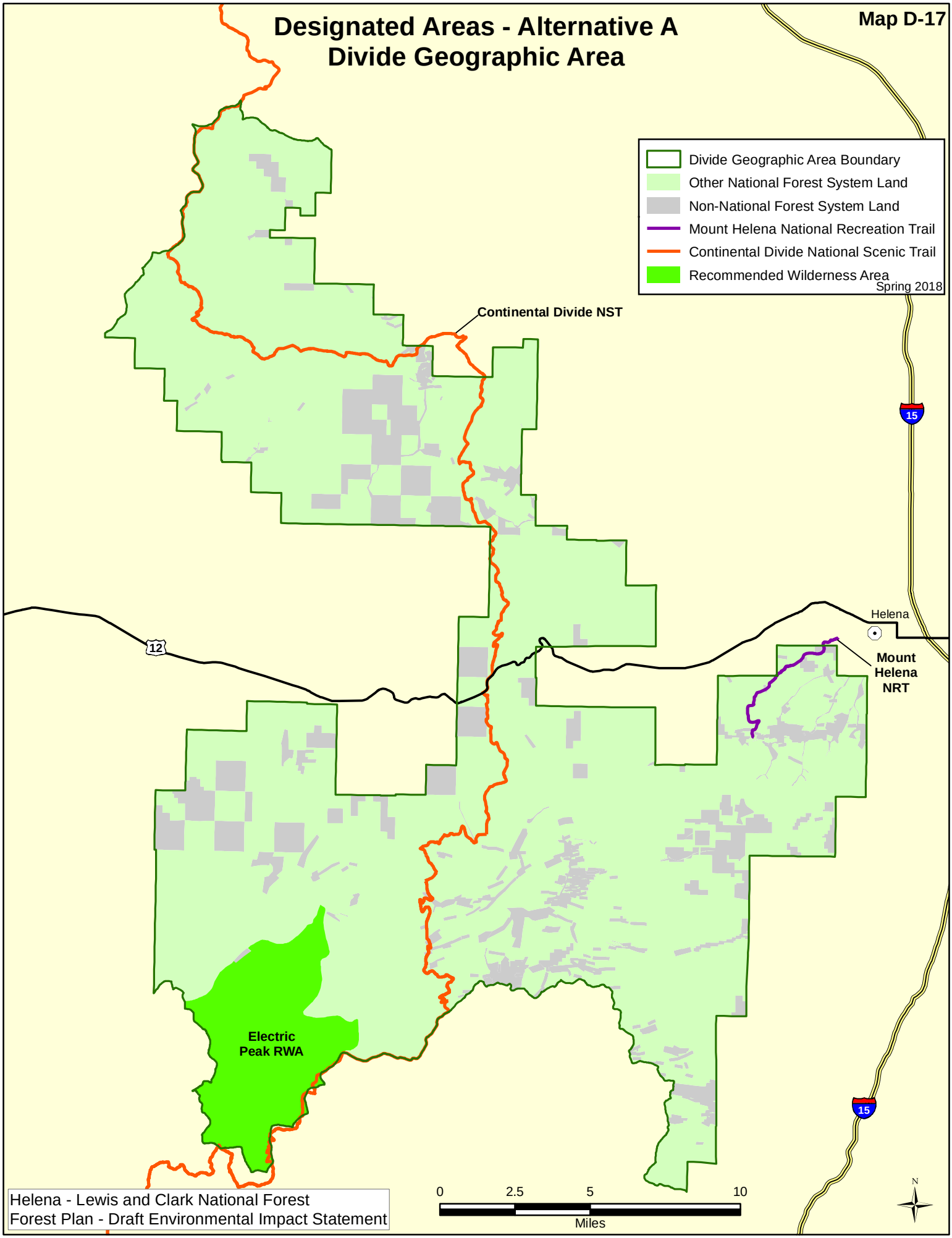
Map D-16



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Designated Areas - Alternative A
Divide Geographic Area

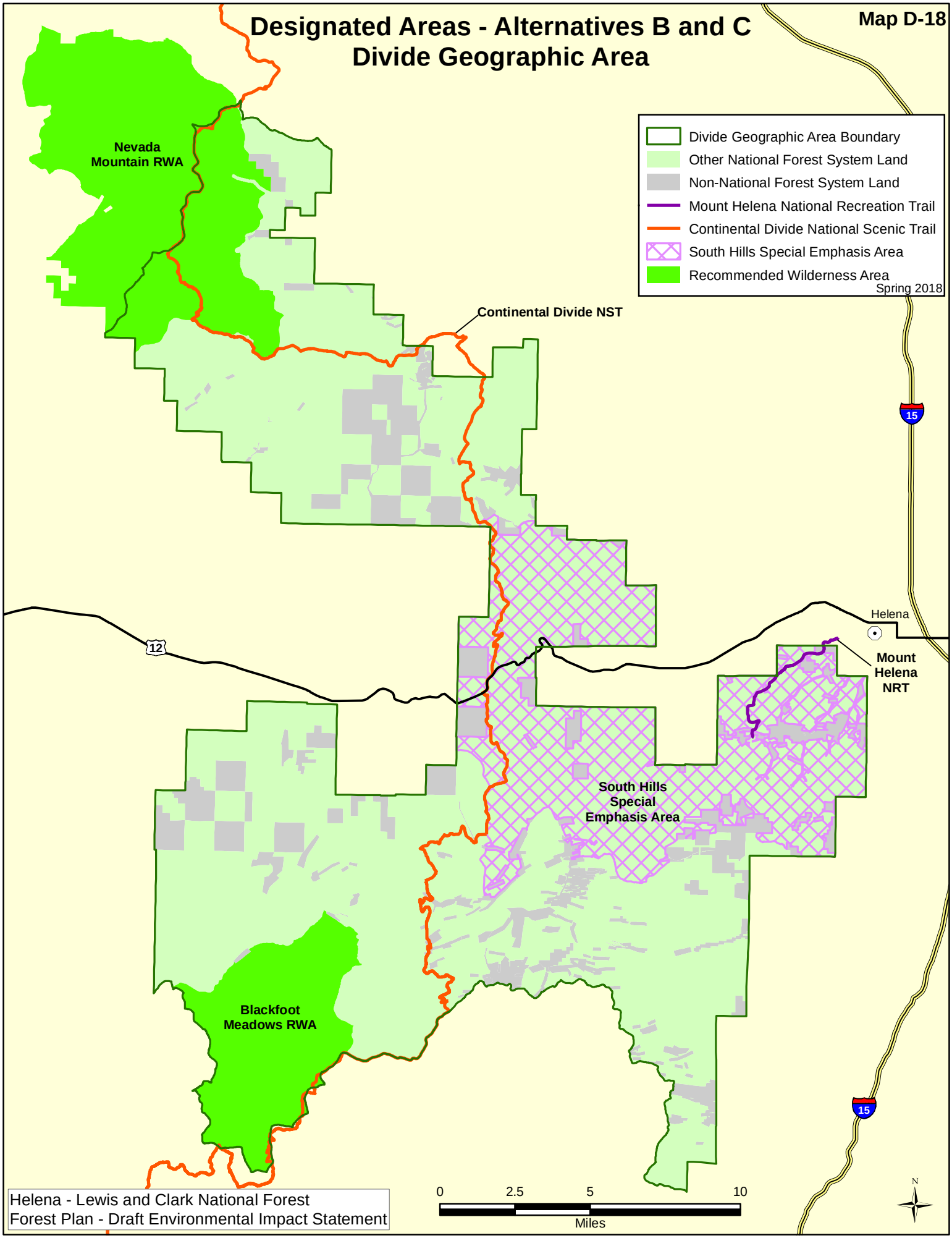
Map D-17



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Designated Areas - Alternatives B and C
Divide Geographic Area

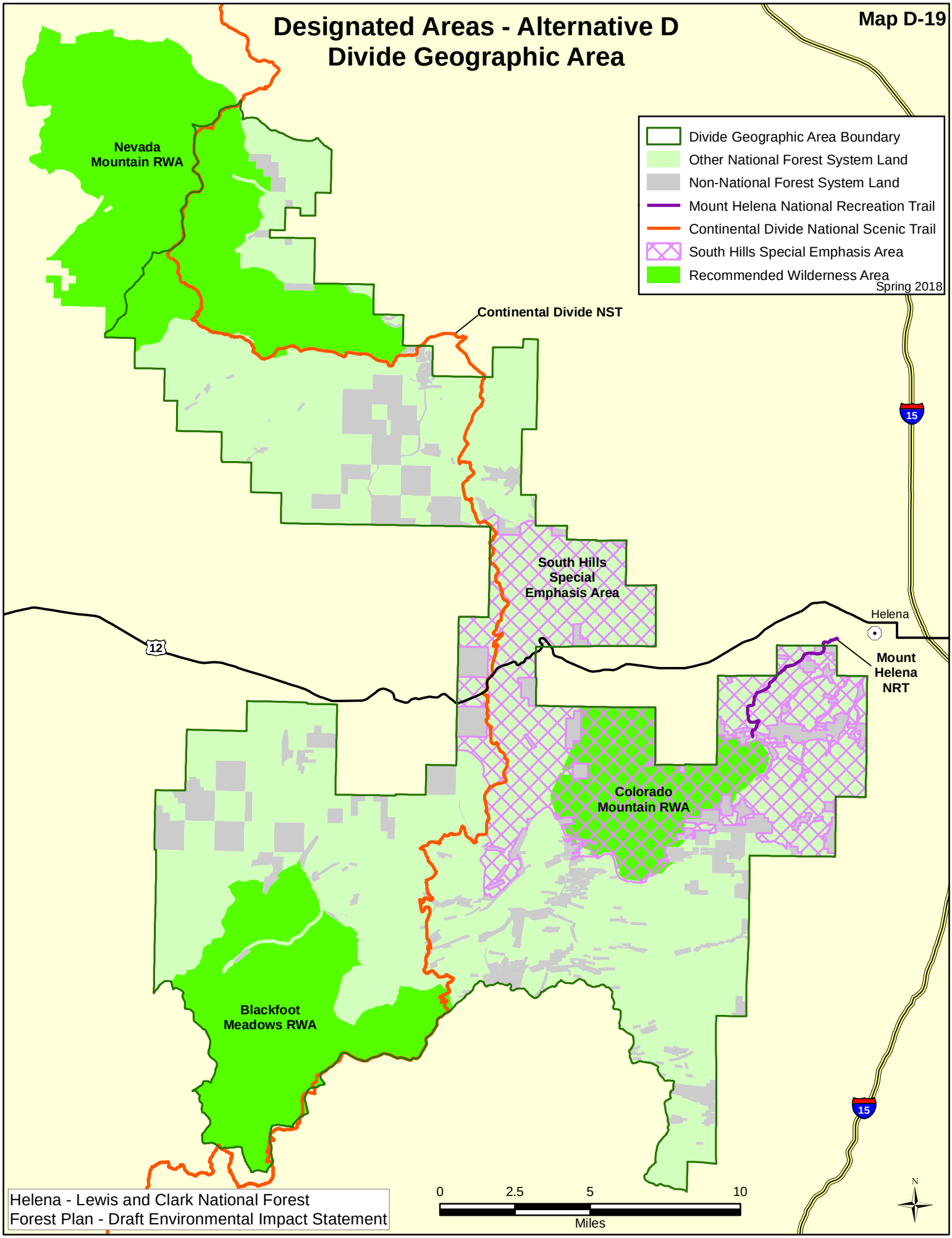
Map D-18



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Designated Areas - Alternative D
Divide Geographic Area

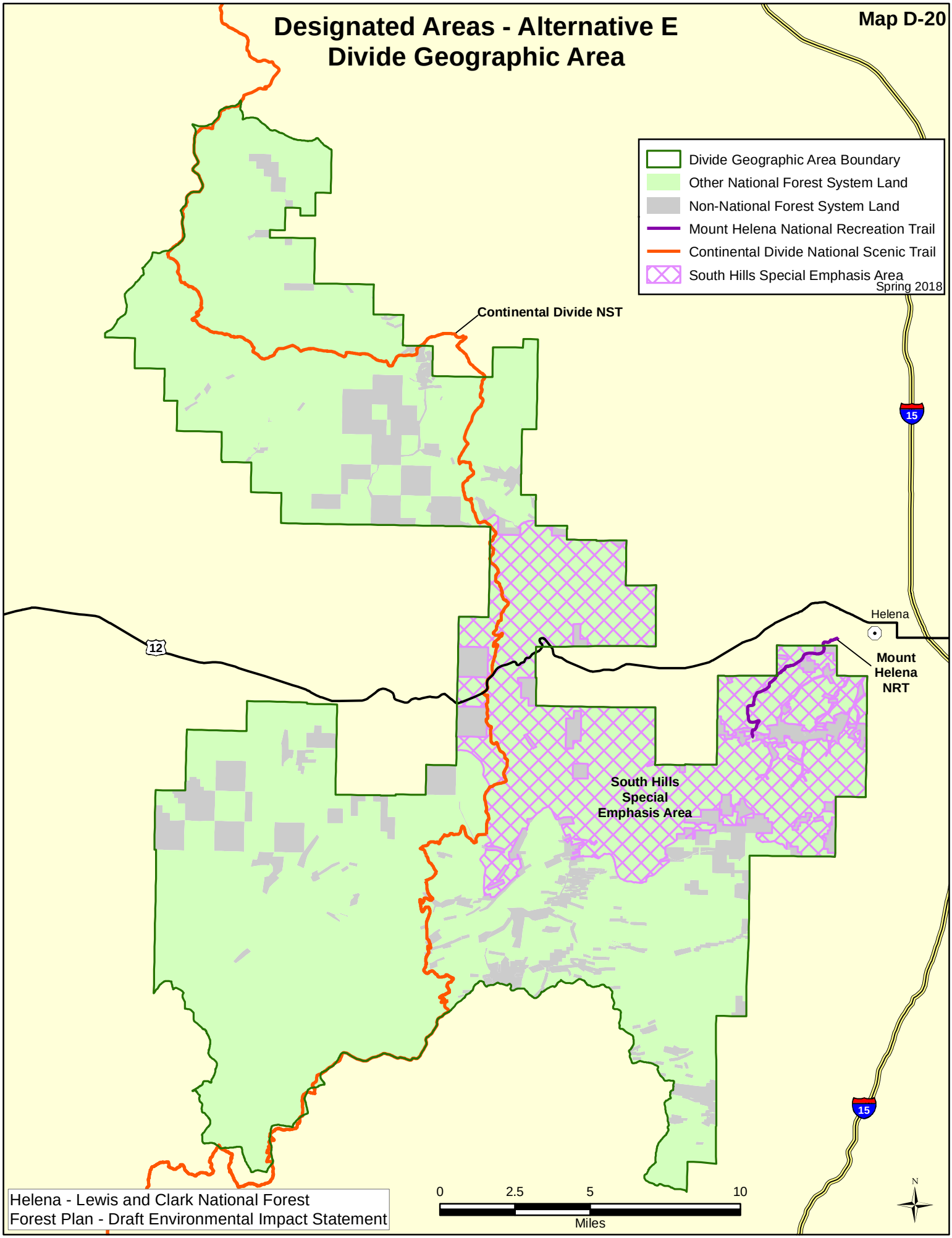
Map D-19



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Designated Areas - Alternative E
Divide Geographic Area

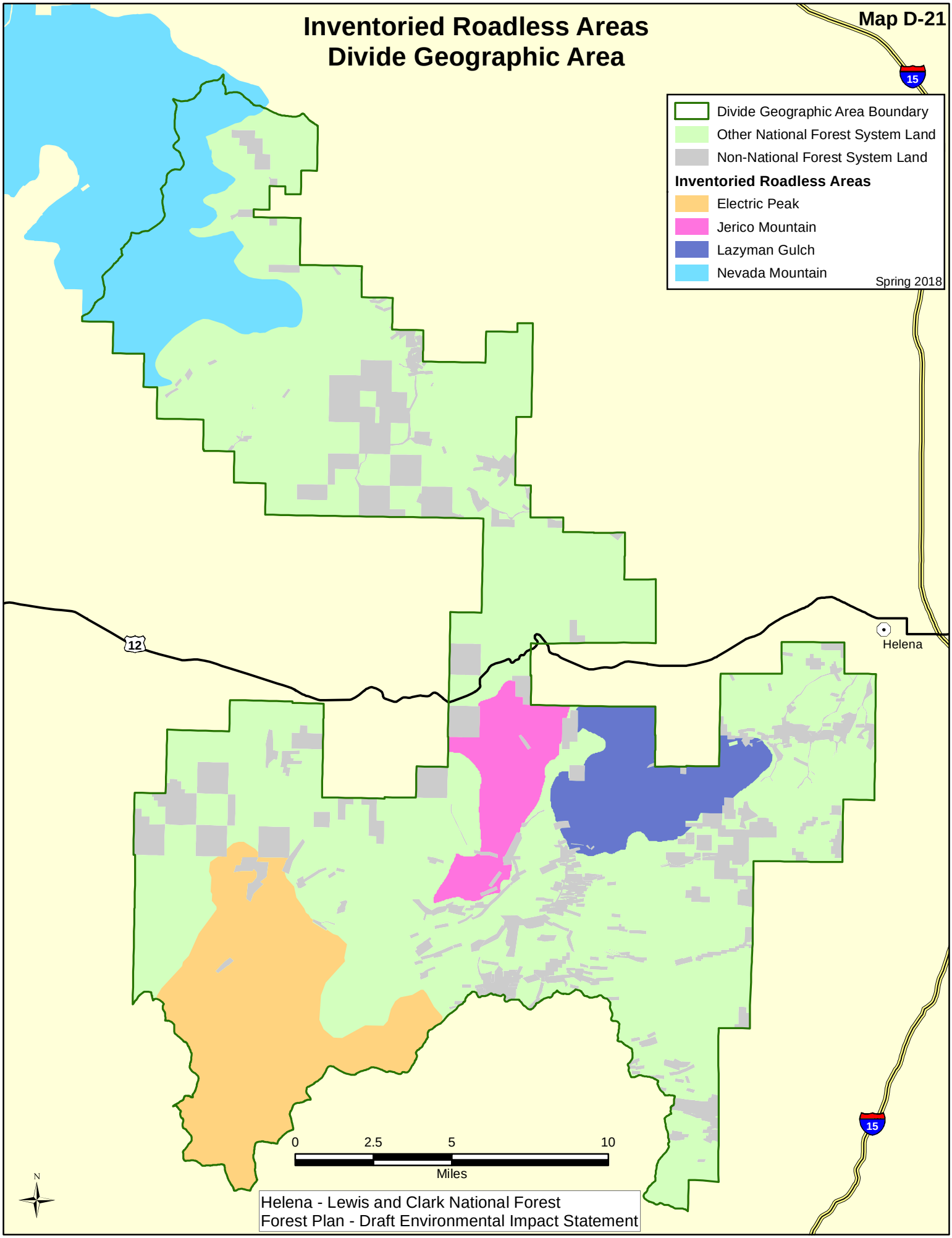
Map D-20



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Inventoried Roadless Areas
Divide Geographic Area

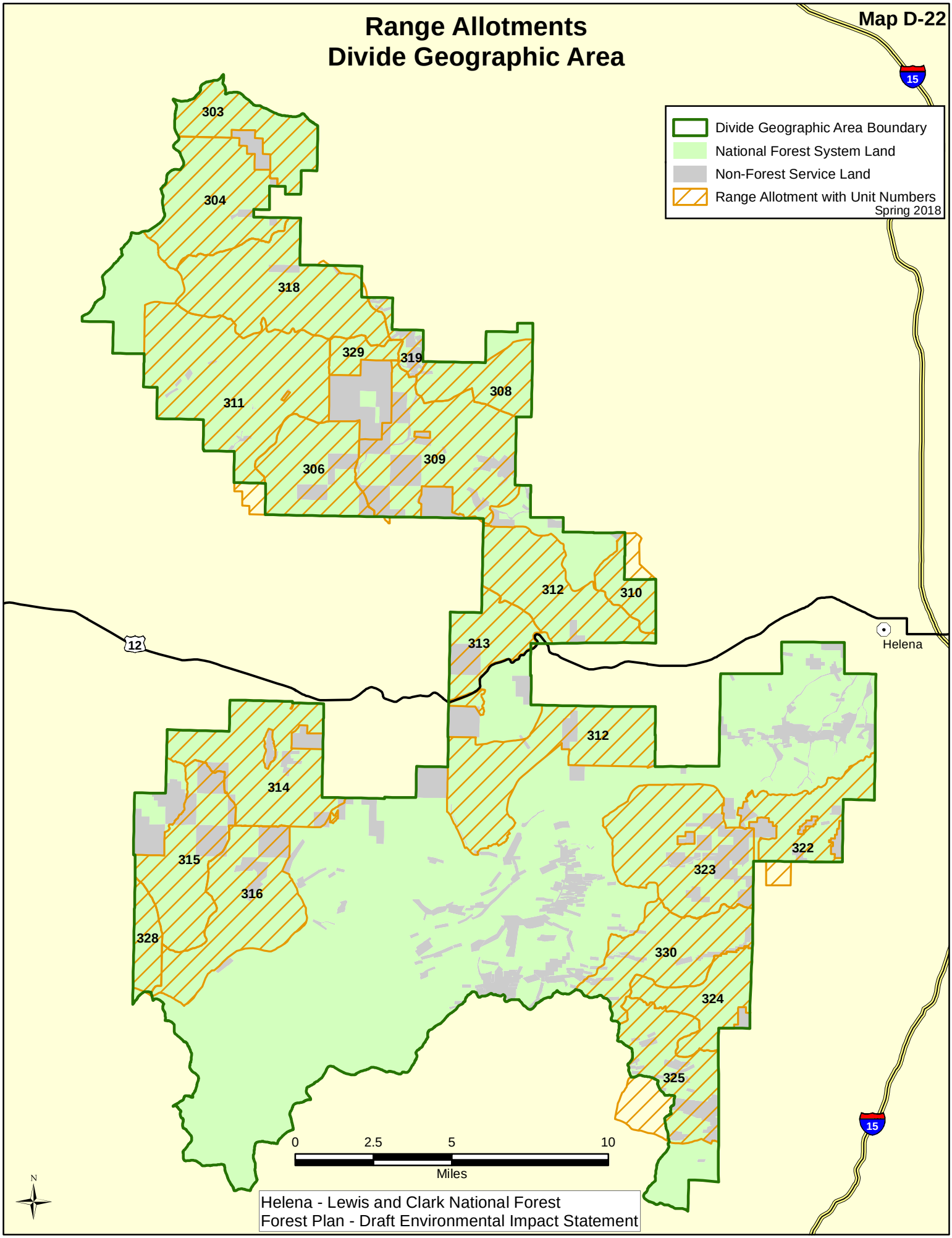
Map D-21



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Range Allotments
Divide Geographic Area

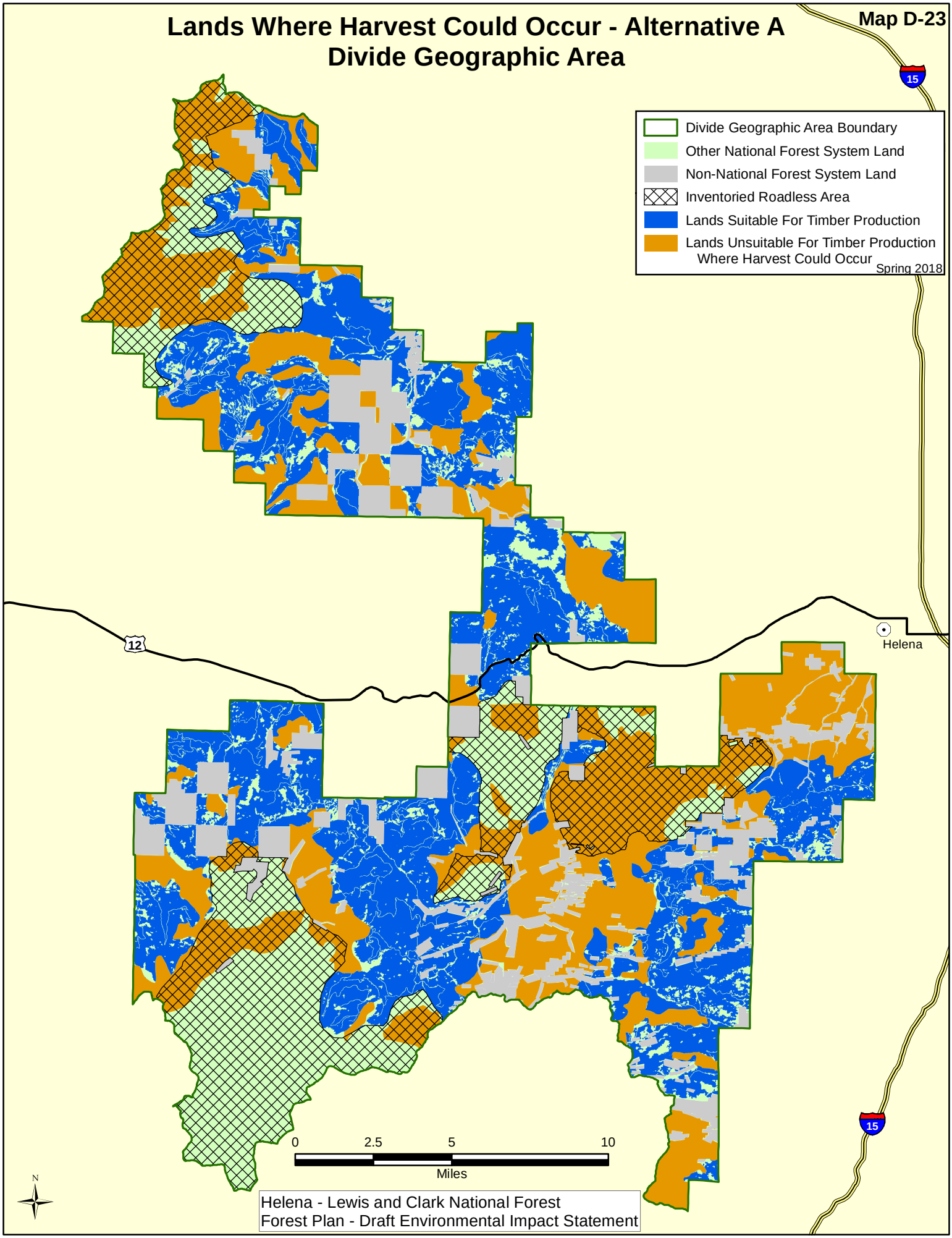
Map D-22



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Lands Where Harvest Could Occur - Alternative A
Divide Geographic Area

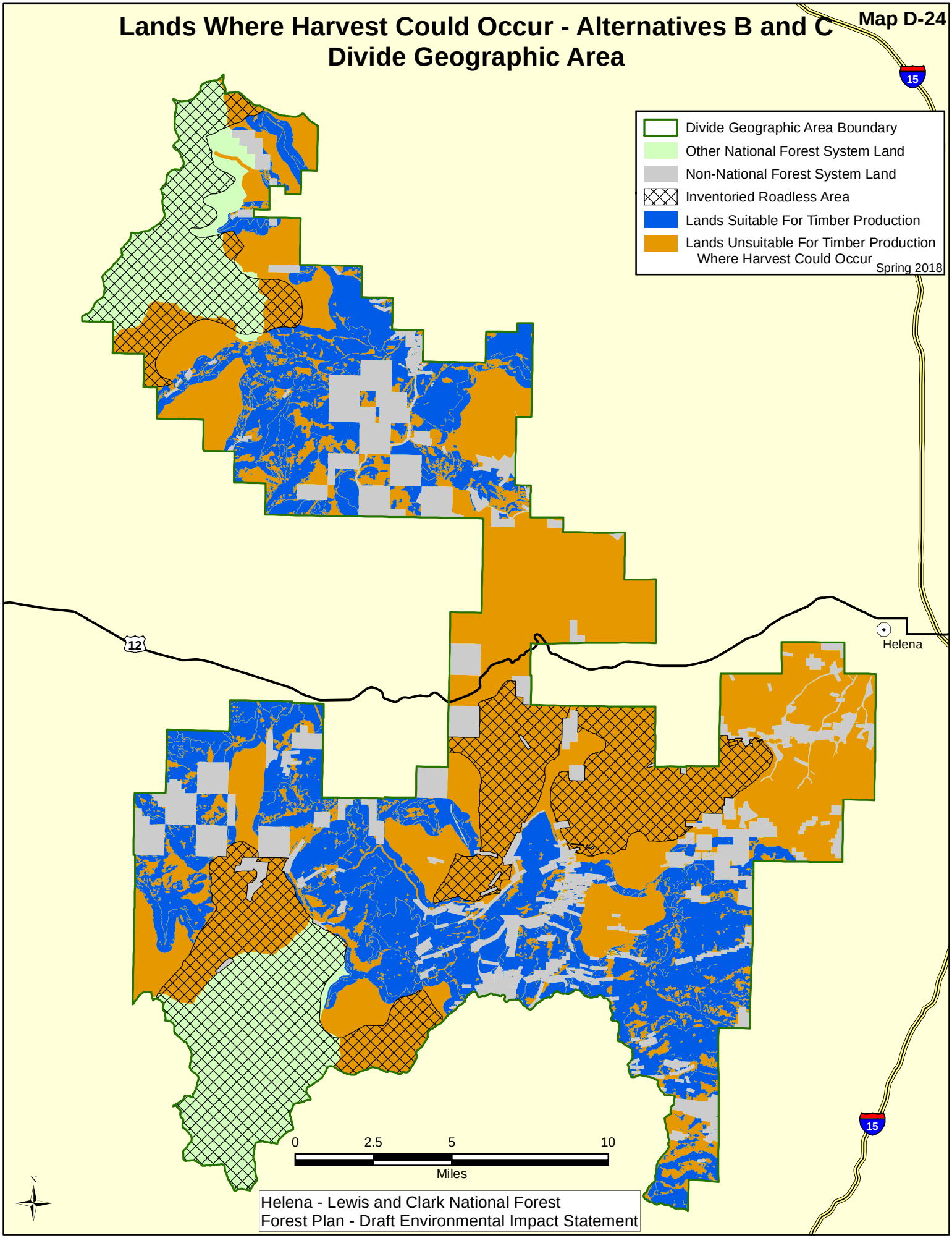
Map D-23



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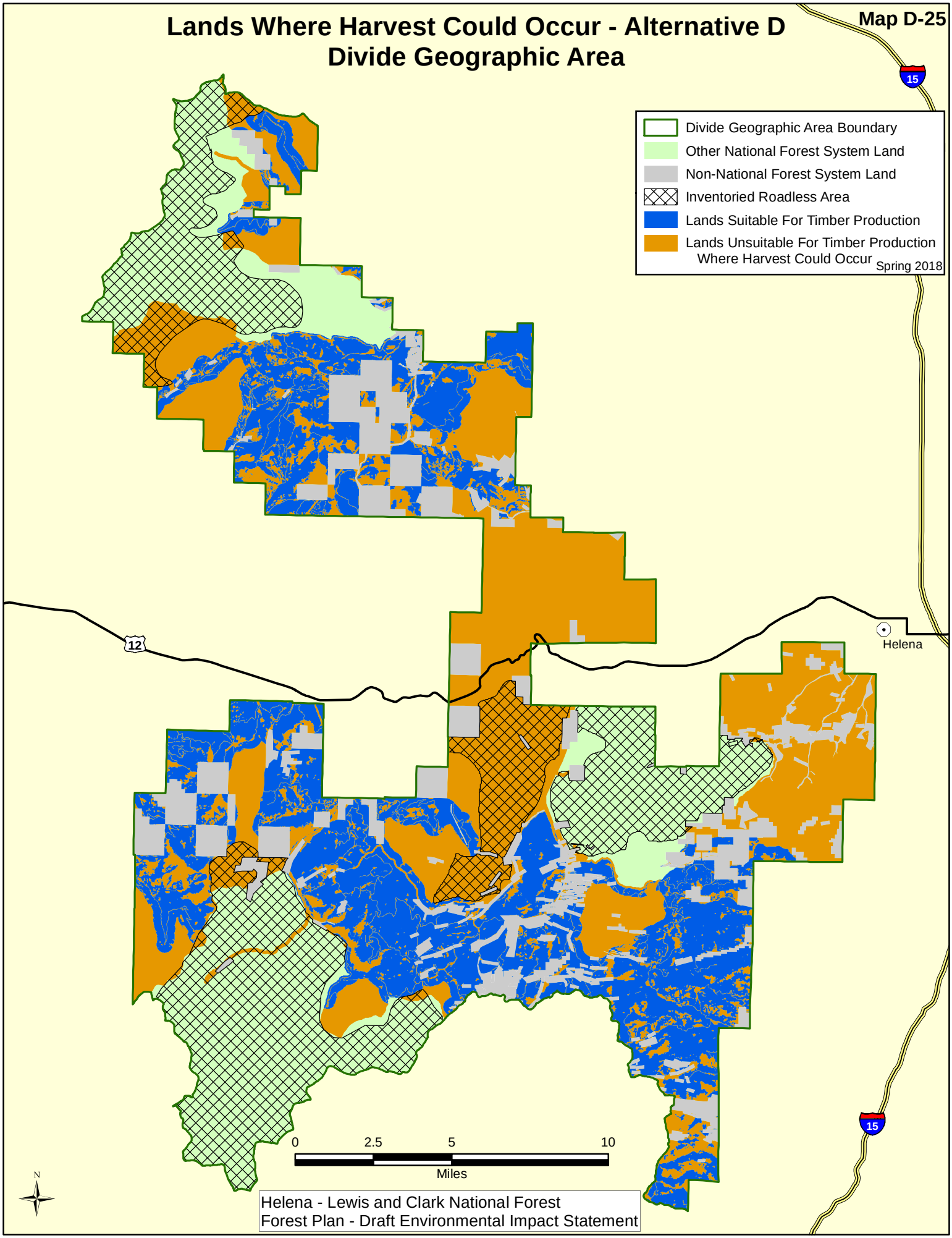
Lands Where Harvest Could Occur - Alternatives B and C
Divide Geographic Area

Map D-24



Lands Where Harvest Could Occur - Alternative D
Divide Geographic Area

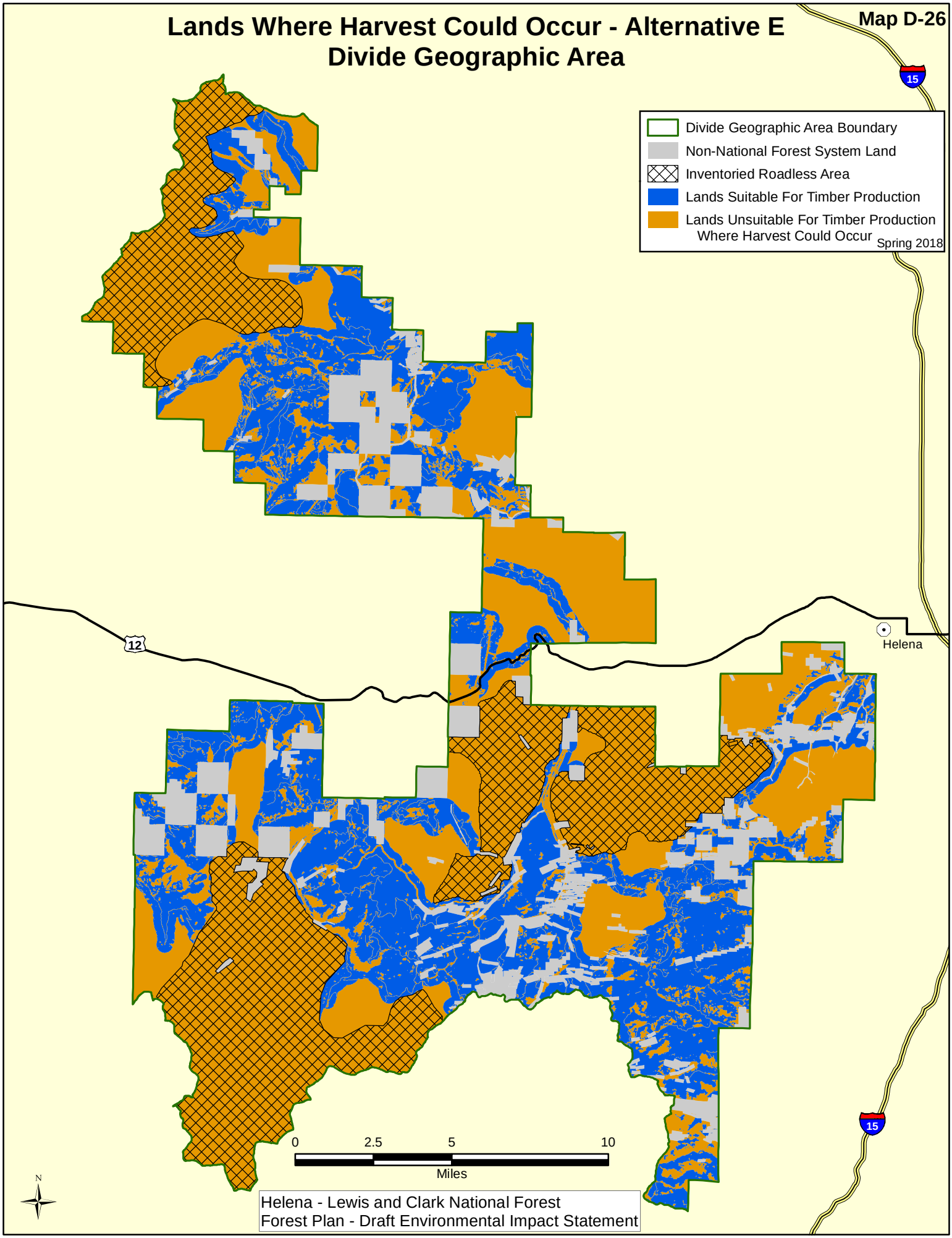
Map D-25



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Lands Where Harvest Could Occur - Alternative E
Divide Geographic Area

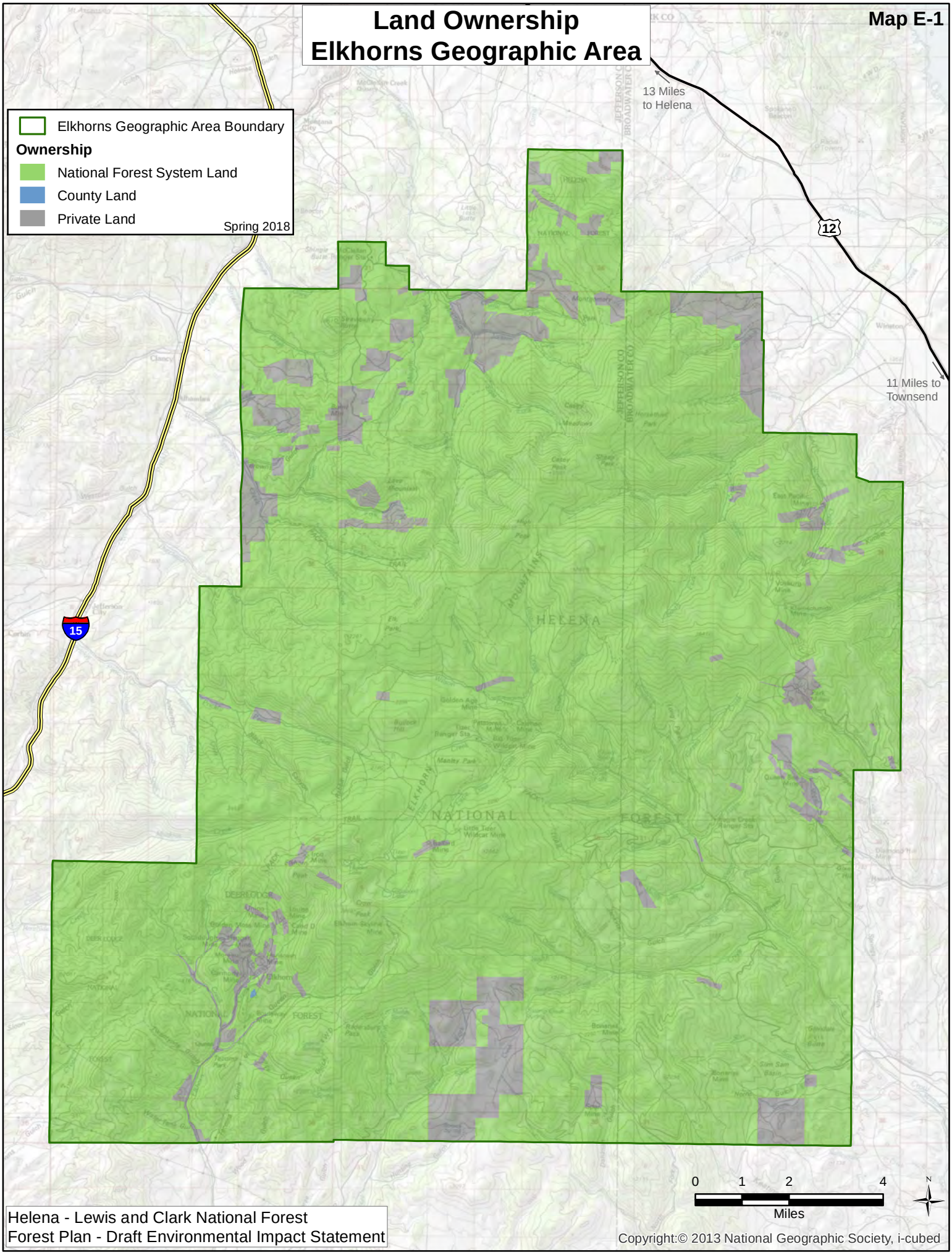
Map D-26



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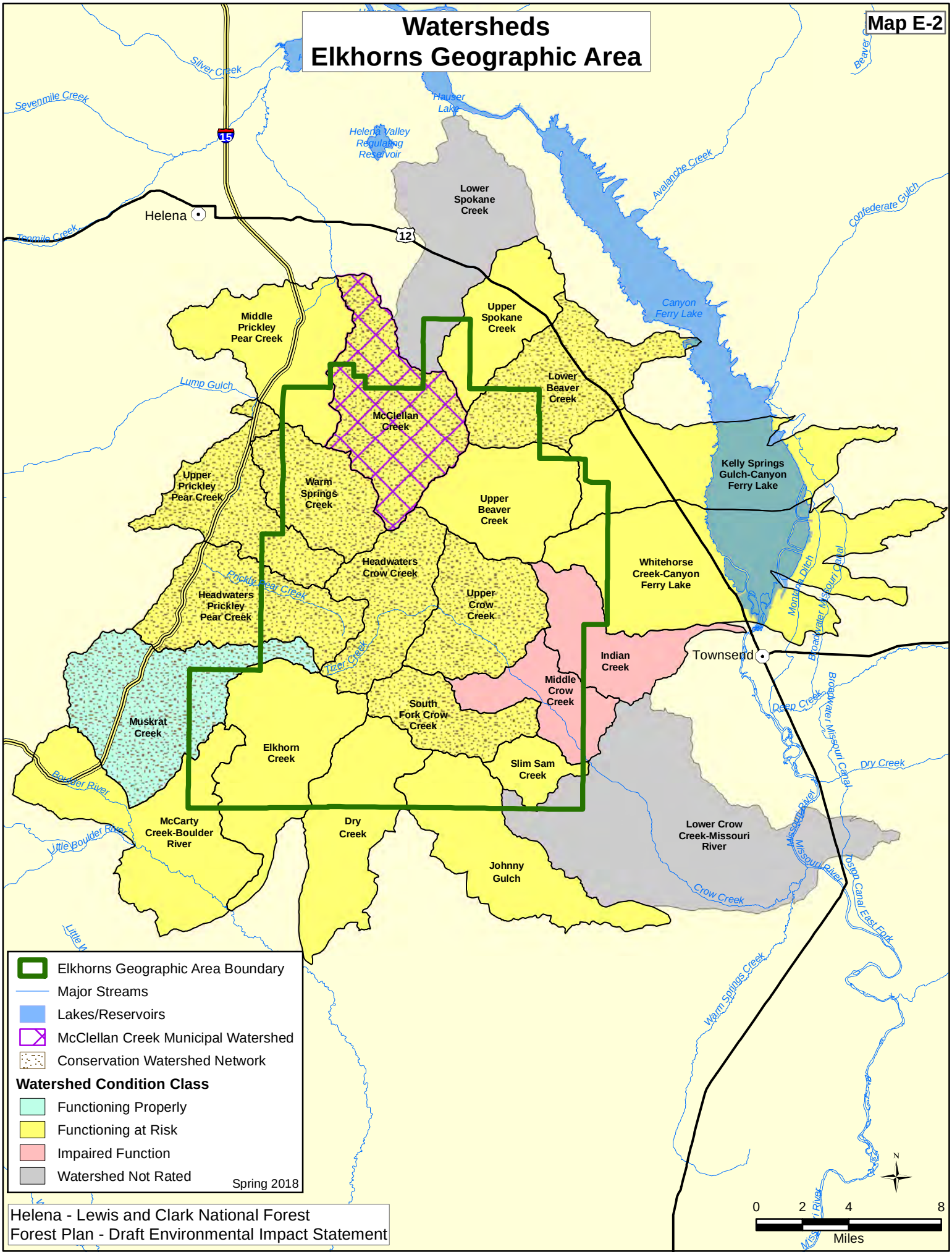
Land Ownership
Elkhorns Geographic Area

Map E-1



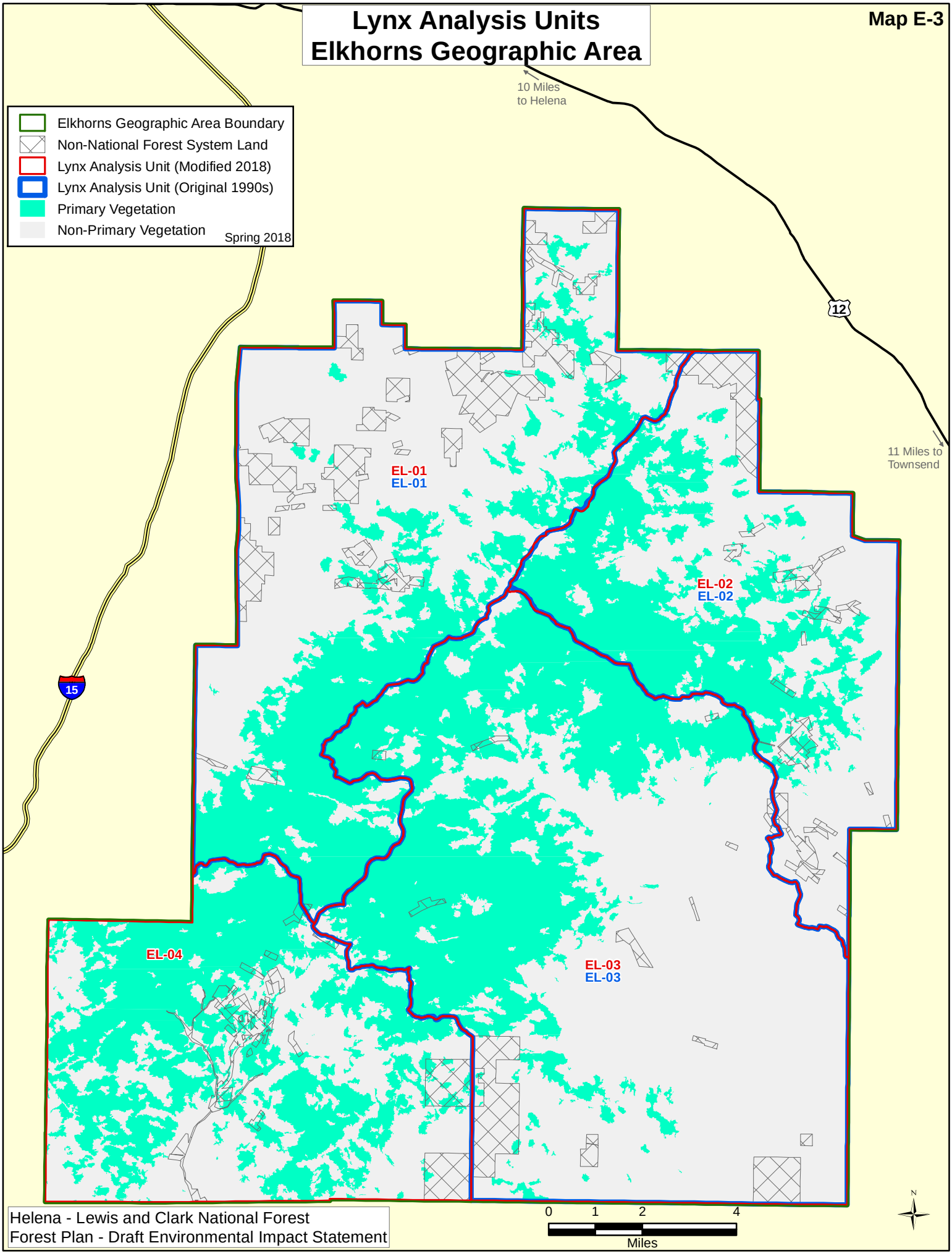
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Watersheds
Elkhorns Geographic Area
Map E-2
Helena
Townsend
Silver Creek
Sevenmile Creek
Tenmile Creek
Hauser Lake
Helena Valley Regulating Reservoir
Avalanche Creek
Beaver
Confederate Gulch
Canyon Ferry Lake
Lump Gulch
Prickly Pear Creek
Tizer Creek
Deep Creek
Dry Creek
Boulder River
Little Boulder River
Crow Creek
Warm Springs Creek
Missouri River
Broadwater Missouri Canal
Montana Ditch
Tosgon Canal East Fork
Lower Spokane Creek
Upper Spokane Creek
Middle Prickley Pear Creek
Upper Prickley Pear Creek
Warm Springs Creek
McClellan Creek
Lower Beaver Creek
Upper Beaver Creek
Kelly Springs Gulch-Canyon Ferry Lake
Whitehorse Creek-Canyon Ferry Lake
Headwaters Crow Creek
Upper Crow Creek
Headwaters Prickley Pear Creek
Indian Creek
Middle Crow Creek
South Fork Crow Creek
Muskrat Creek
Elkhorn Creek
Slim Sam Creek
McCarty Creek-Boulder River
Dry Creek
Johnny Gulch
Lower Crow Creek-Missouri River
Elkhorns Geographic Area Boundary
Major Streams
Lakes/Reservoirs
McClellan Creek Municipal Watershed
Conservation Watershed Network
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018
N
0 2 4 8
Miles
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Lynx Analysis Units
Elkhorns Geographic Area

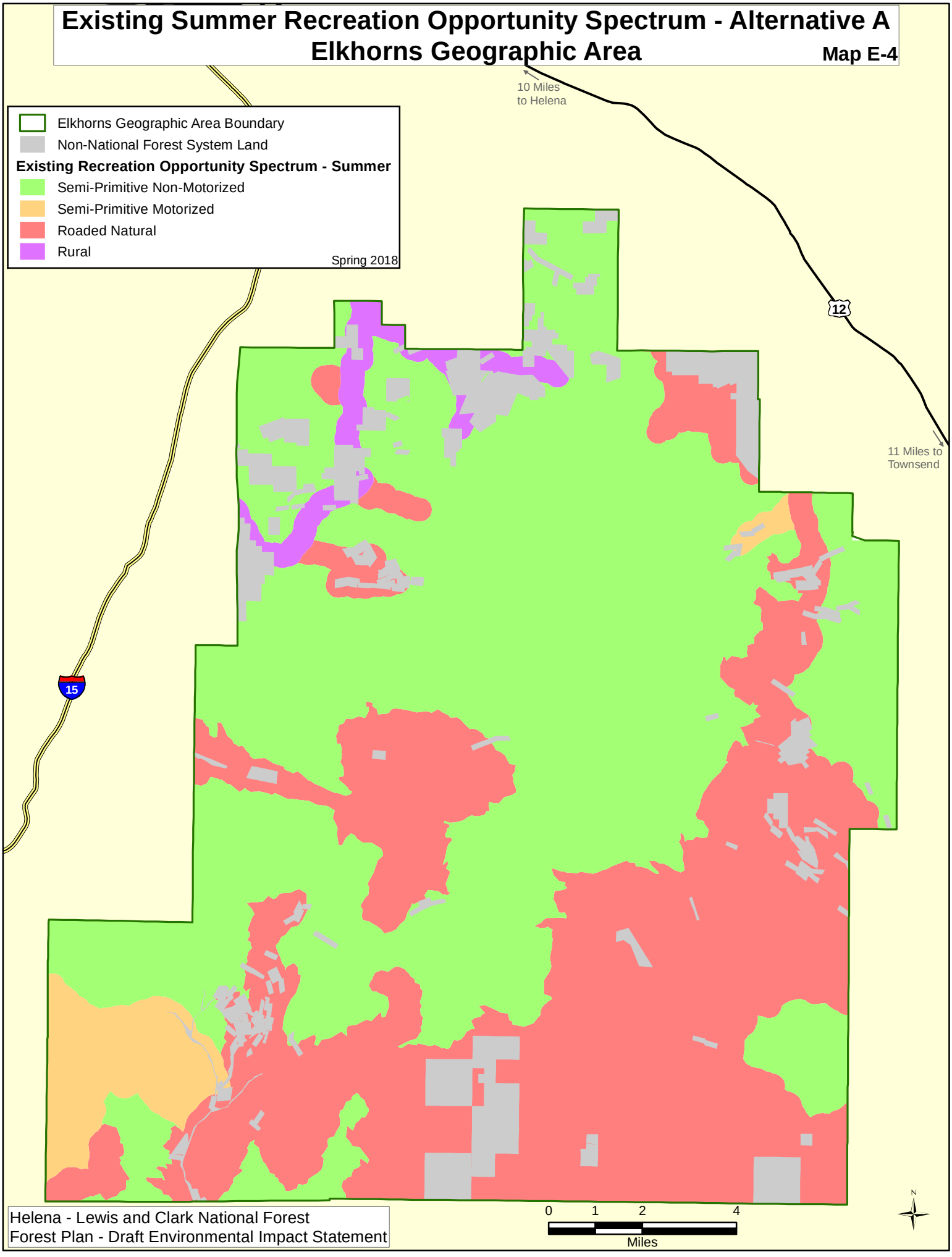
Map E-3



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Existing Summer Recreation Opportunity Spectrum - Alternative A
Elkhorns Geographic Area

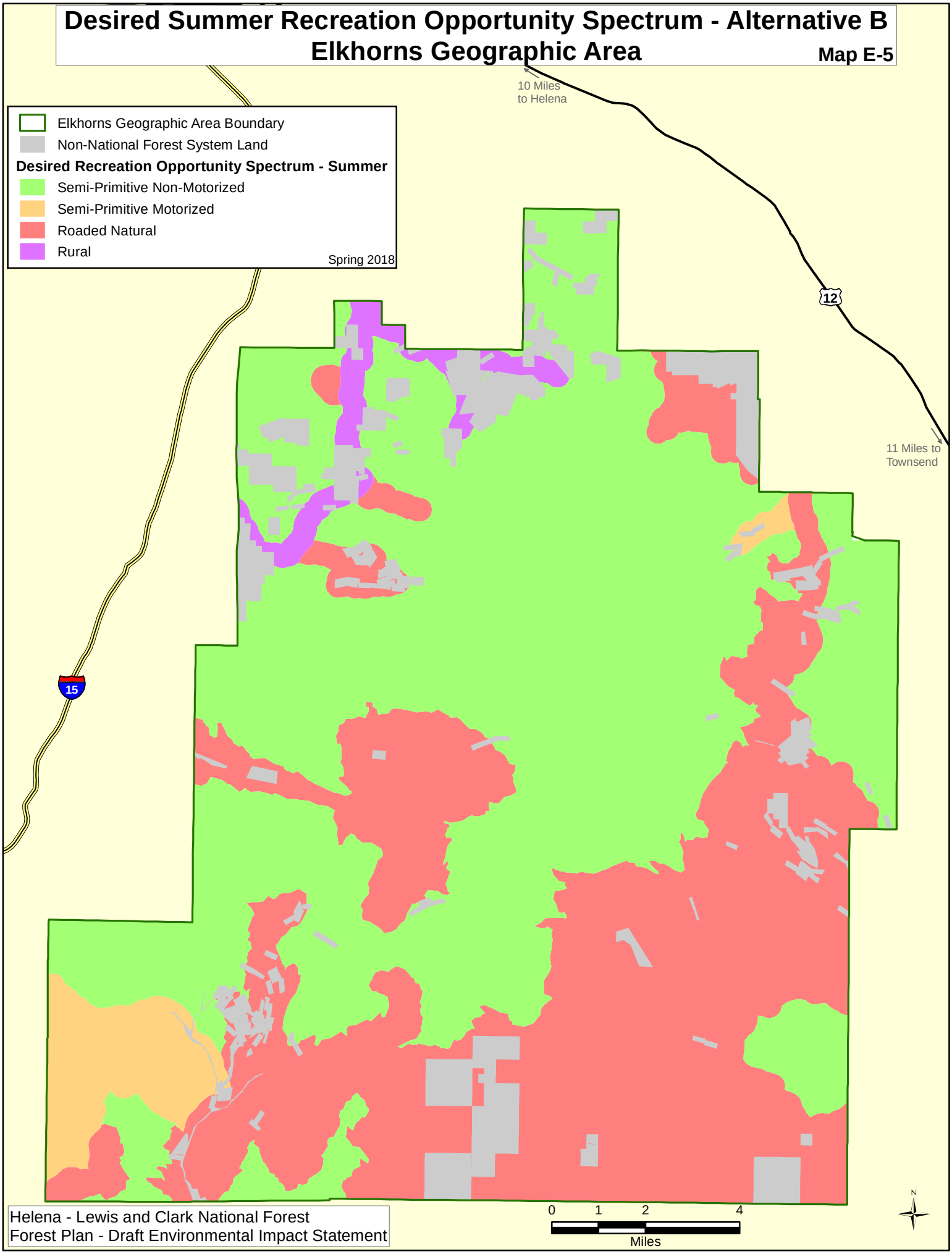
Map E-4



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Desired Summer Recreation Opportunity Spectrum - Alternative B
Elkhorns Geographic Area

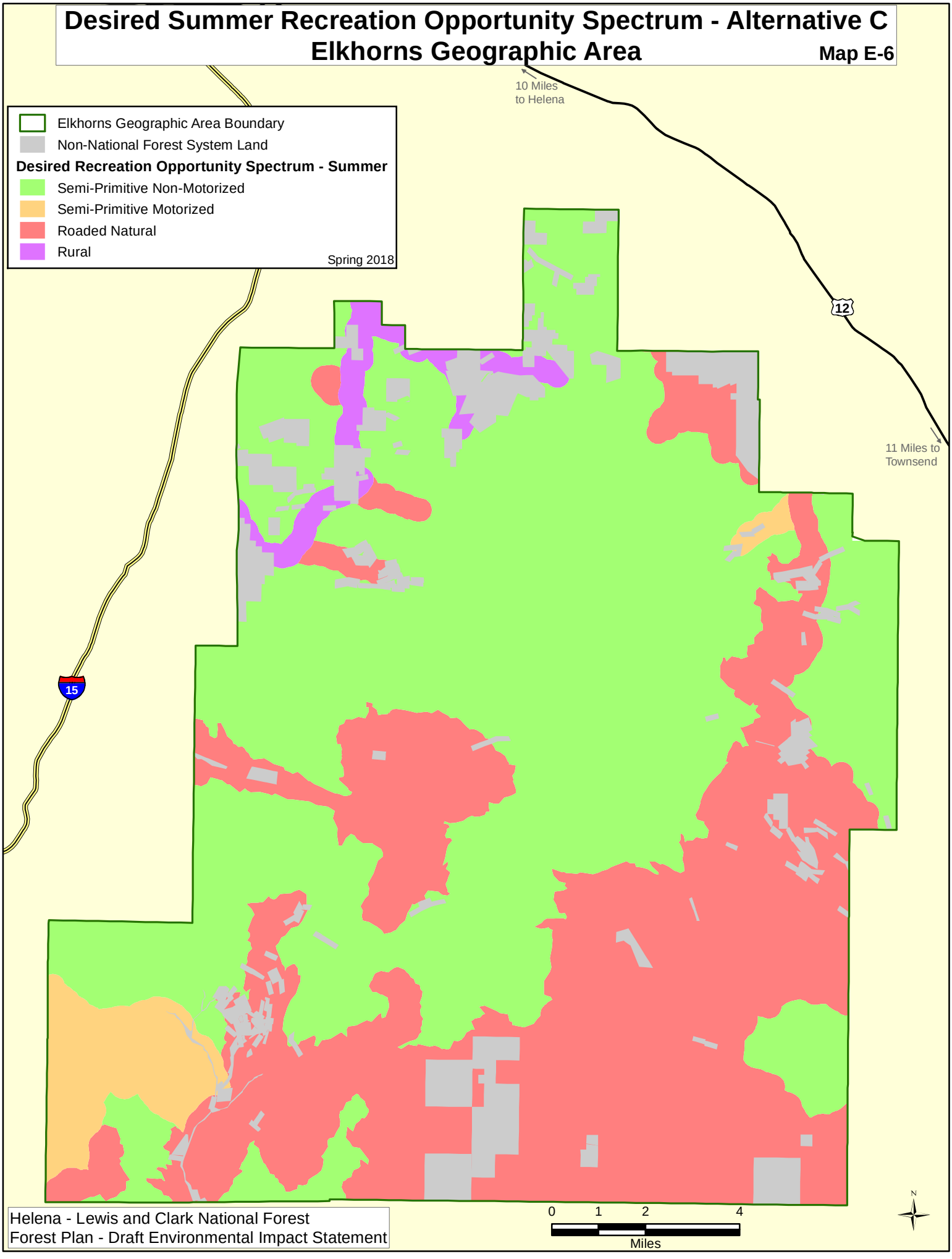
Map E-5



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Desired Summer Recreation Opportunity Spectrum - Alternative C
Elkhorns Geographic Area

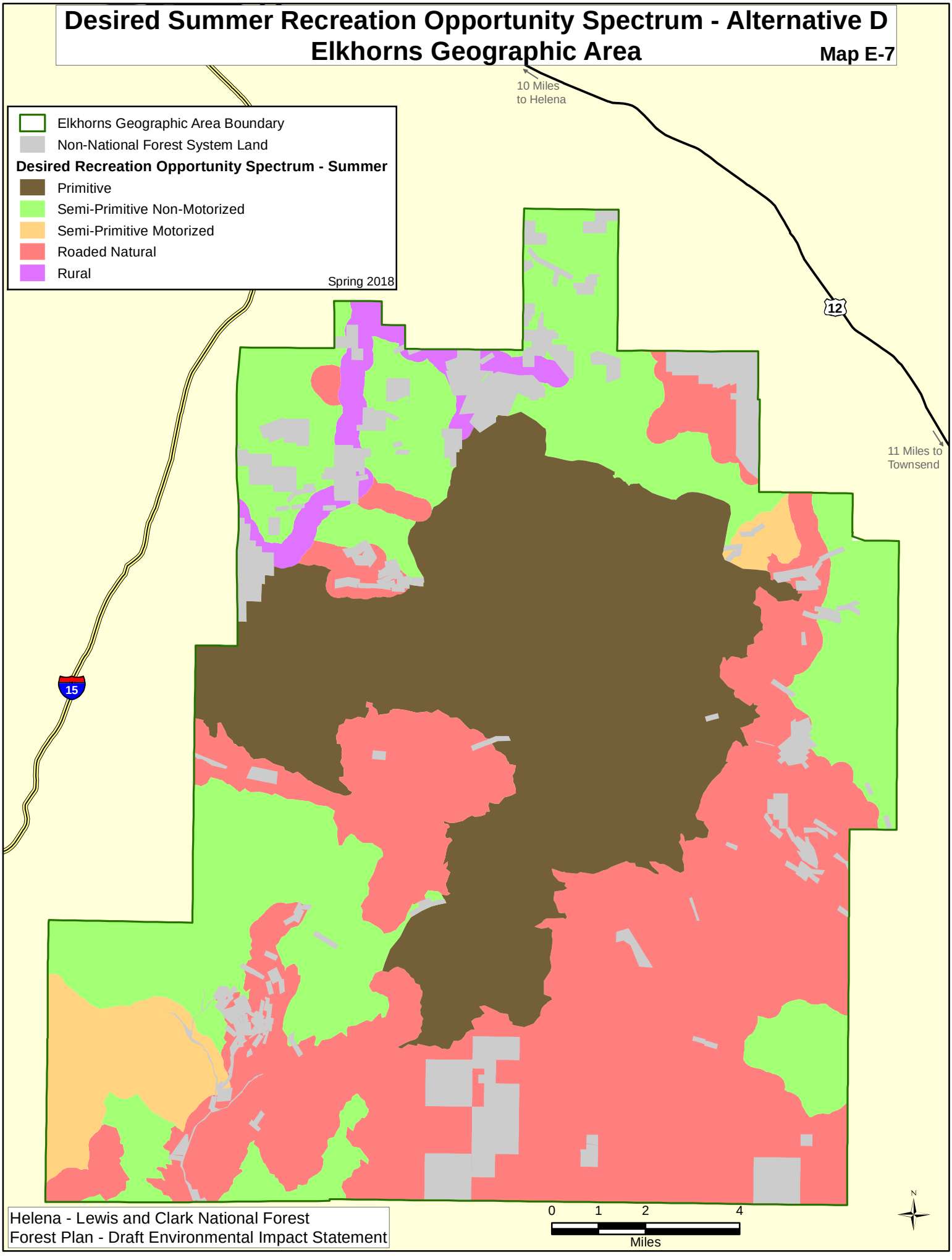
Map E-6



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Elkhorns Geographic Area

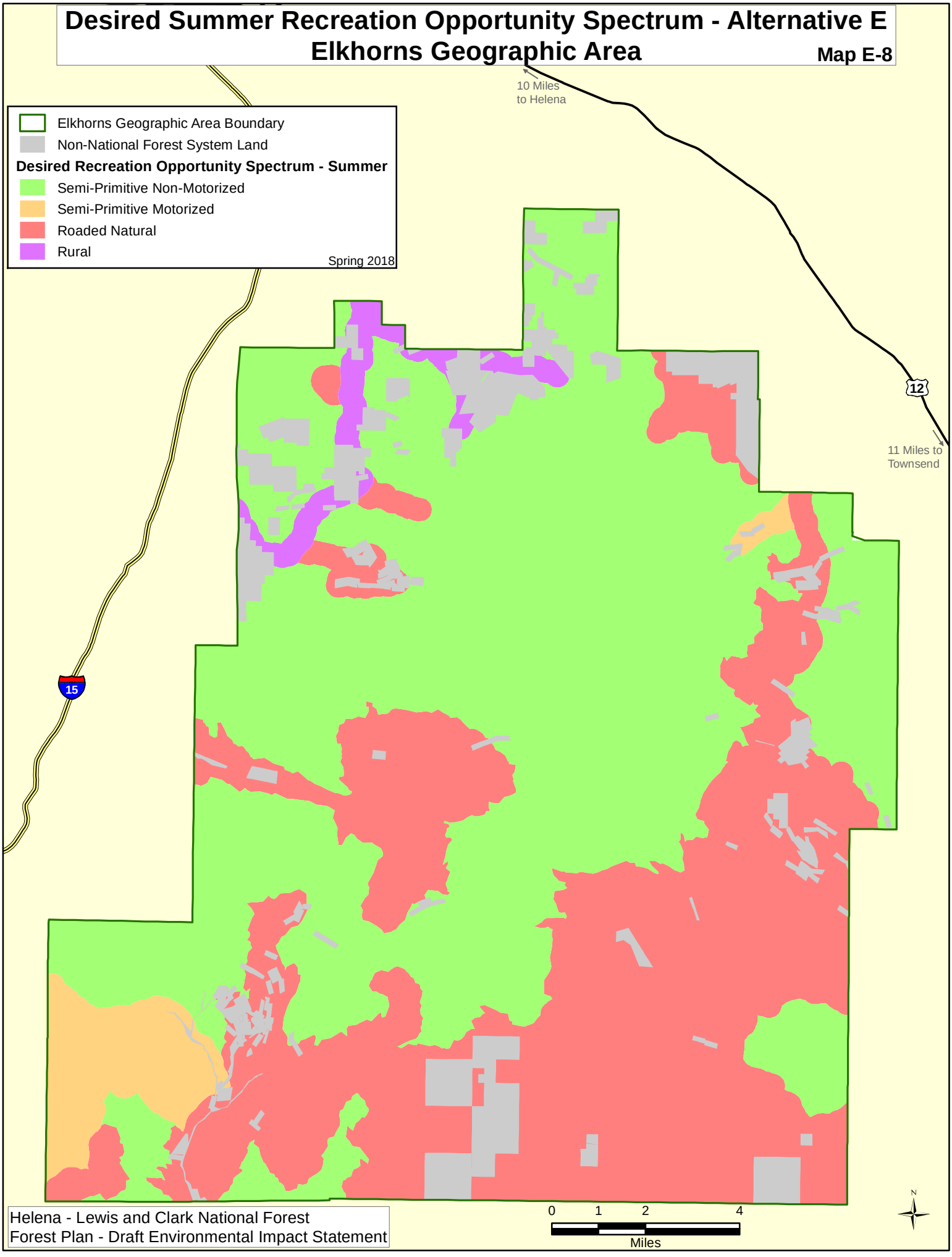
Map E-7



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Desired Summer Recreation Opportunity Spectrum - Alternative E
Elkhorns Geographic Area

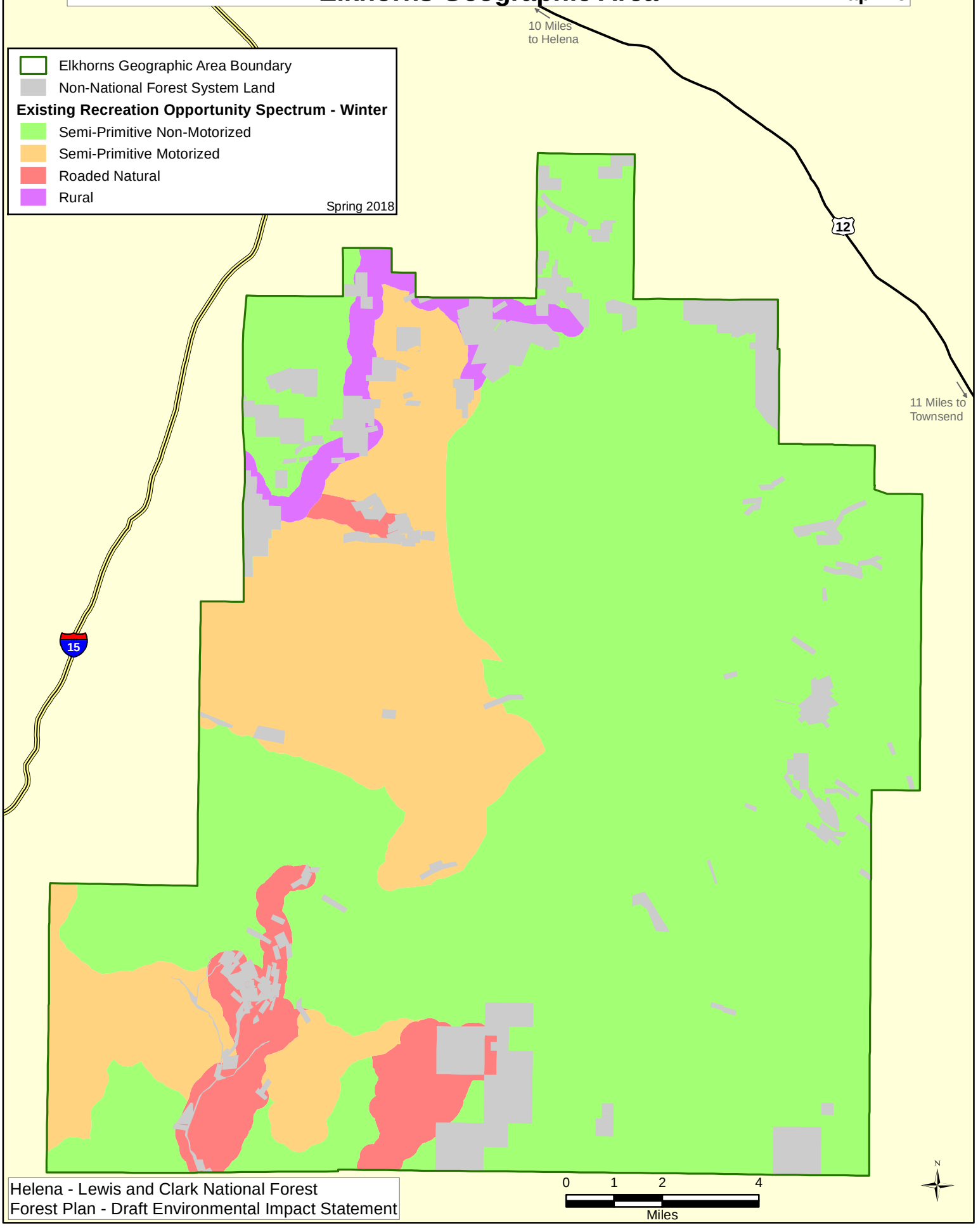
Map E-8



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Elkhorns Geographic Area

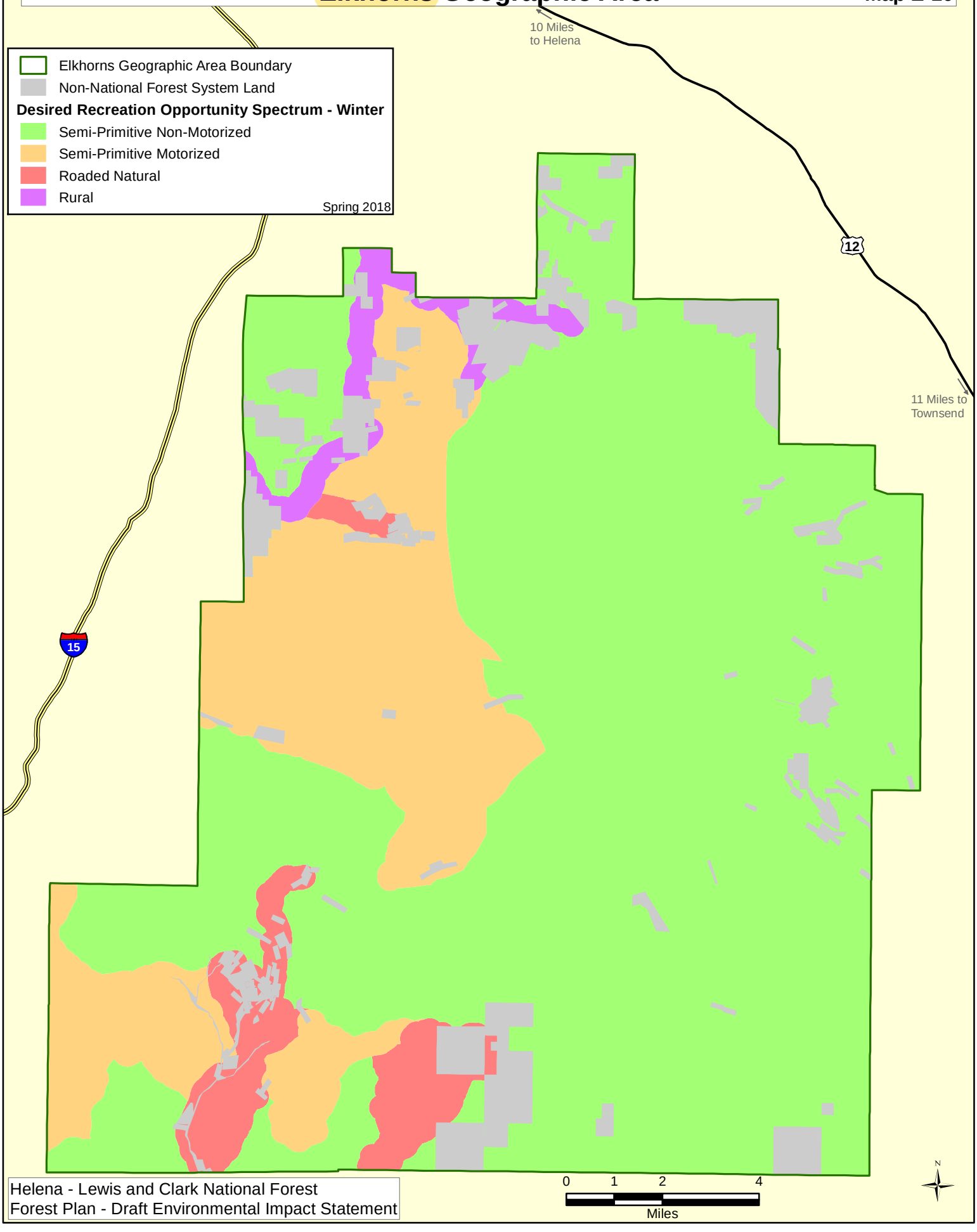
Map E-9



Helena - Lewis and Clark National Forest
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Desired Winter Recreation Opportunity Spectrum - Alternatives B and E
Elkhorns Geographic Area

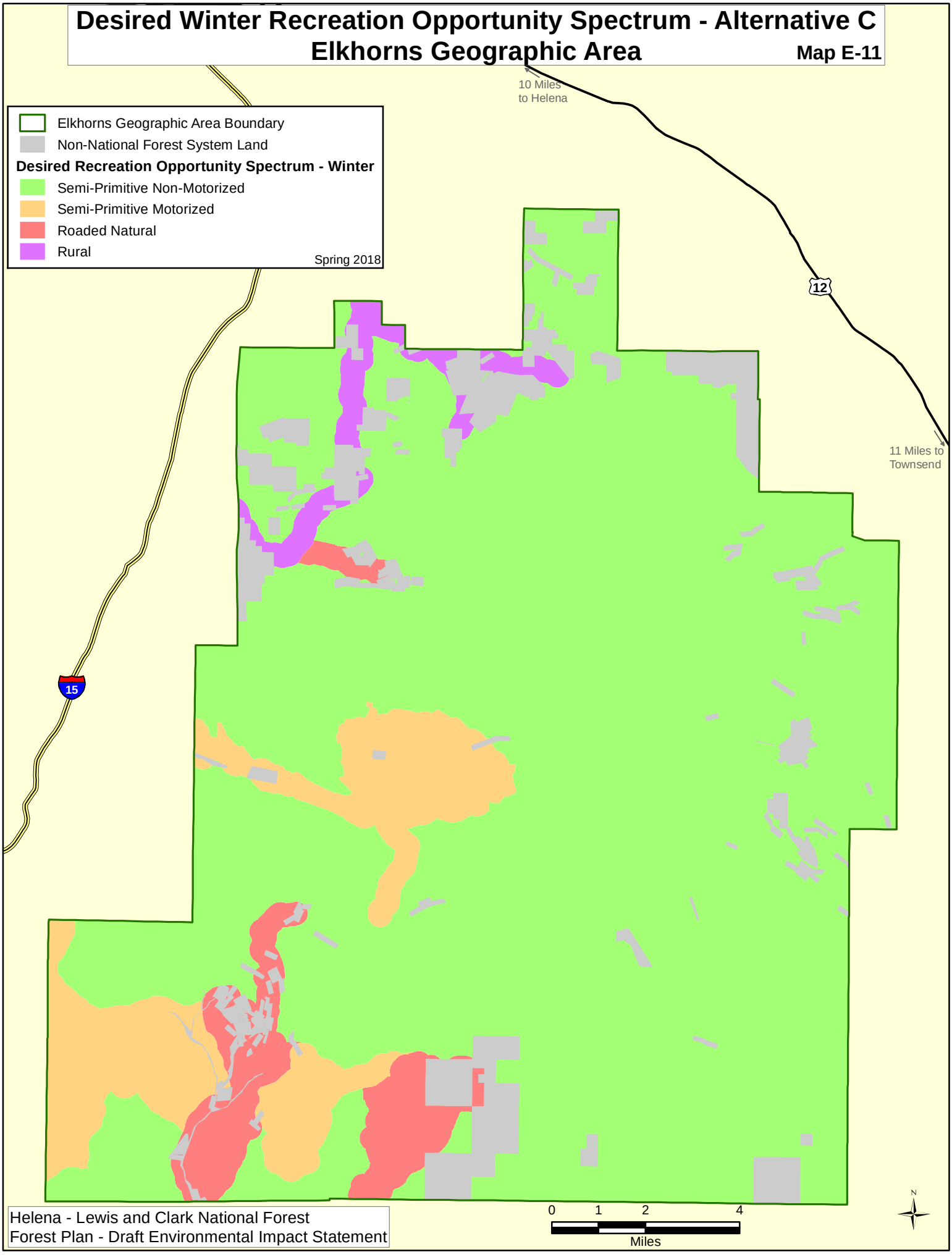
Map E-10



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Desired Winter Recreation Opportunity Spectrum - Alternative C
Elkhorns Geographic Area

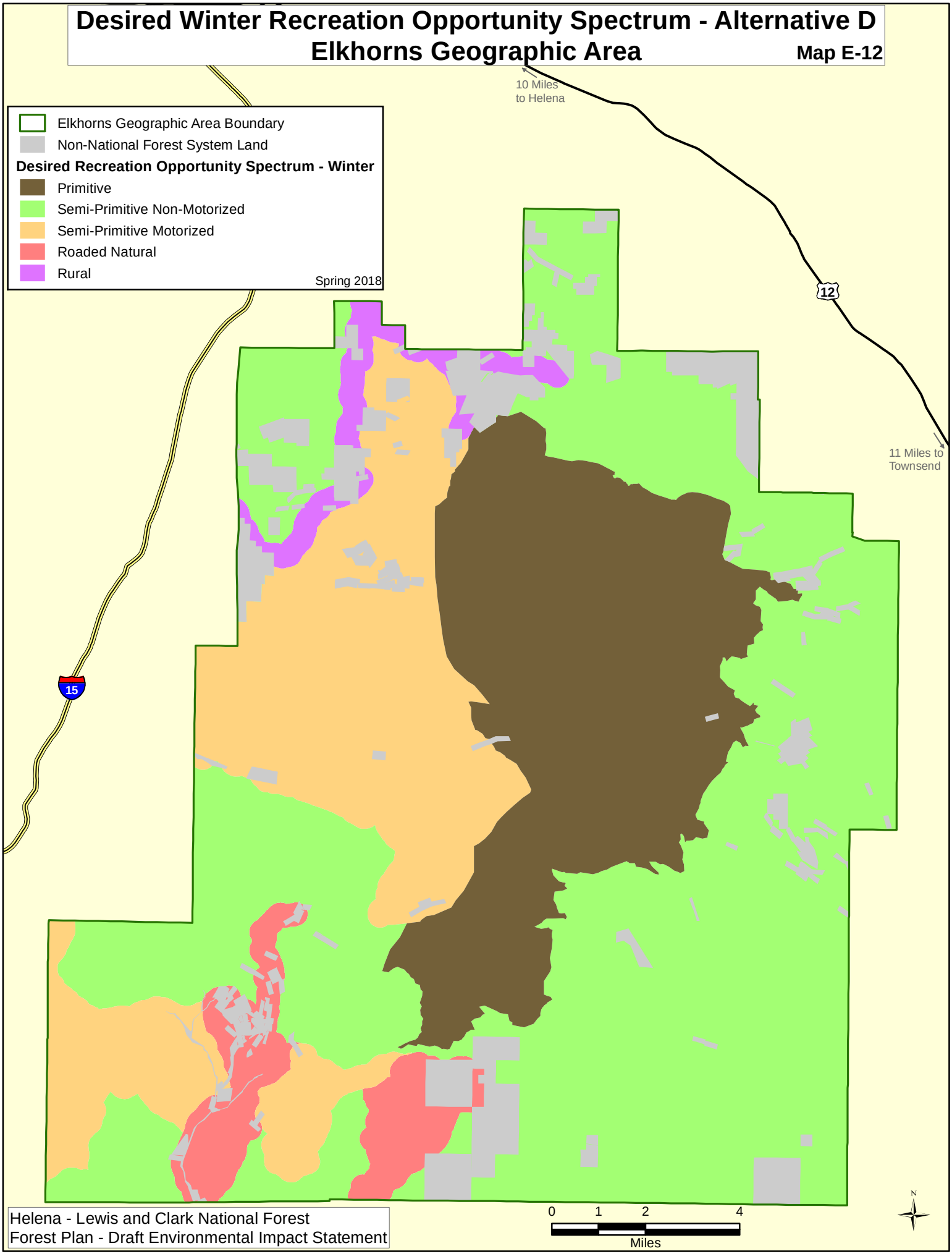
Map E-11



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Desired Winter Recreation Opportunity Spectrum - Alternative D
Elkhorns Geographic Area

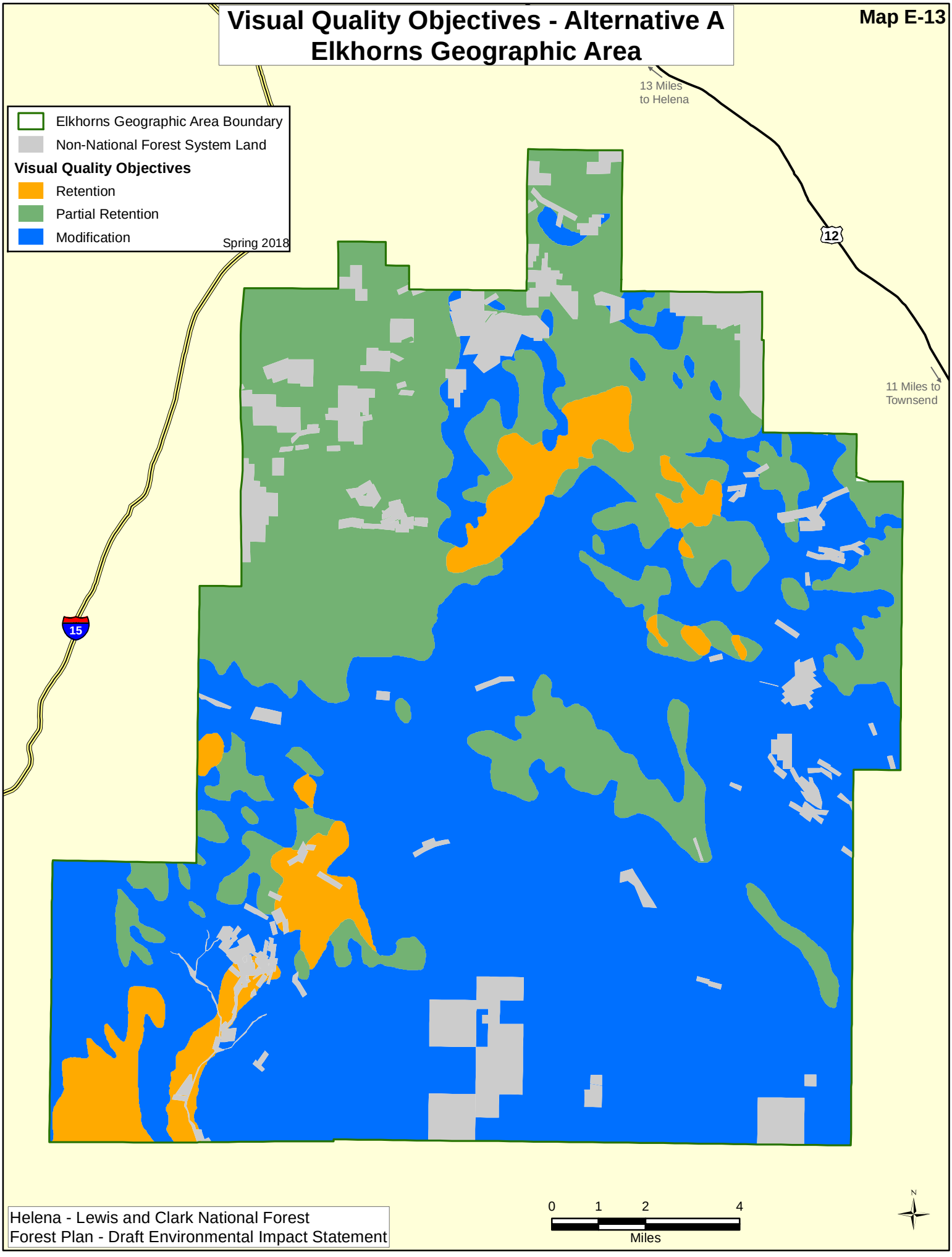
Map E-12



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Visual Quality Objectives - Alternative A
Elkhorns Geographic Area

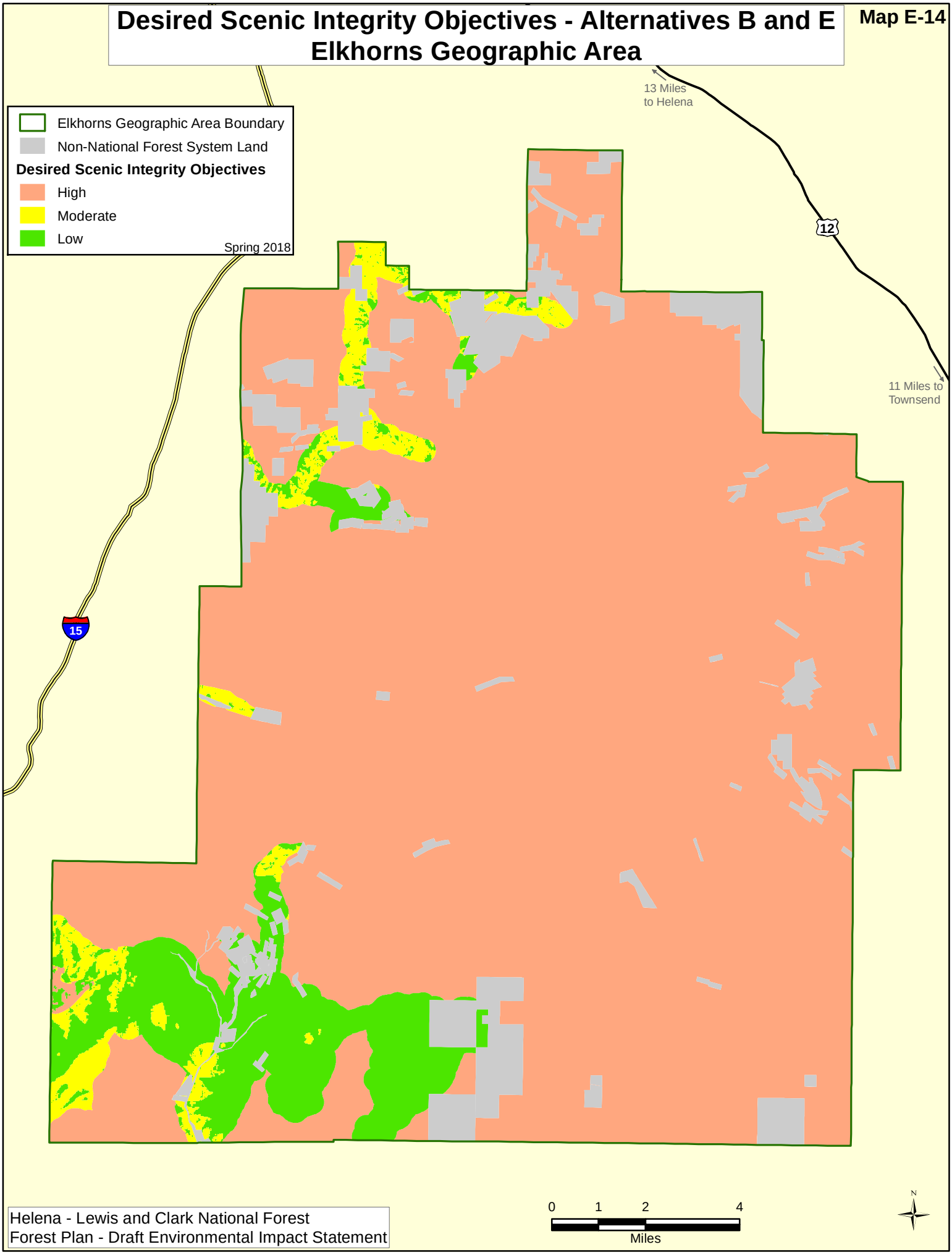
Map E-13



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Desired Scenic Integrity Objectives - Alternatives B and E
Elkhorns Geographic Area

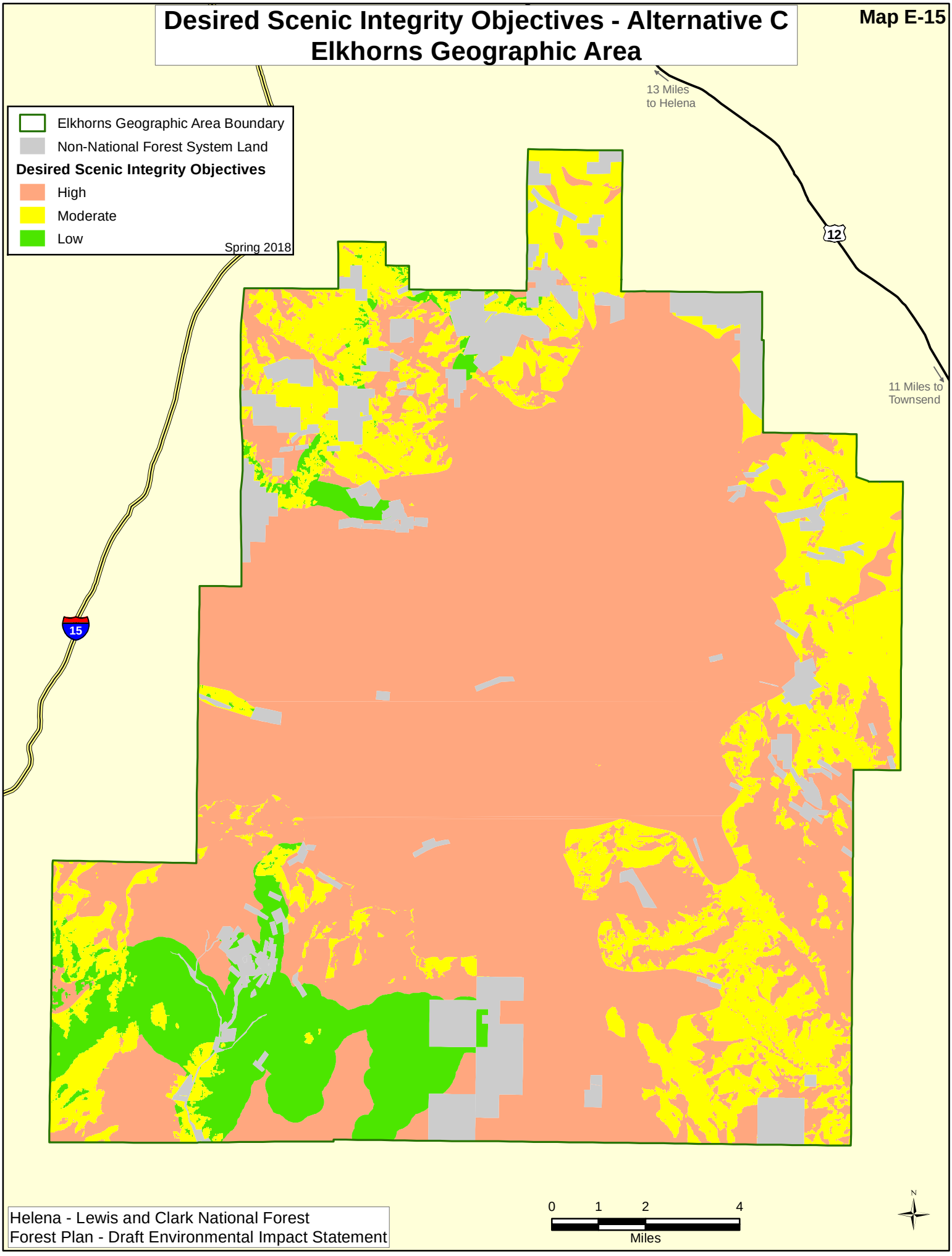
Map E-14



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Desired Scenic Integrity Objectives - Alternative C
Elkhorns Geographic Area

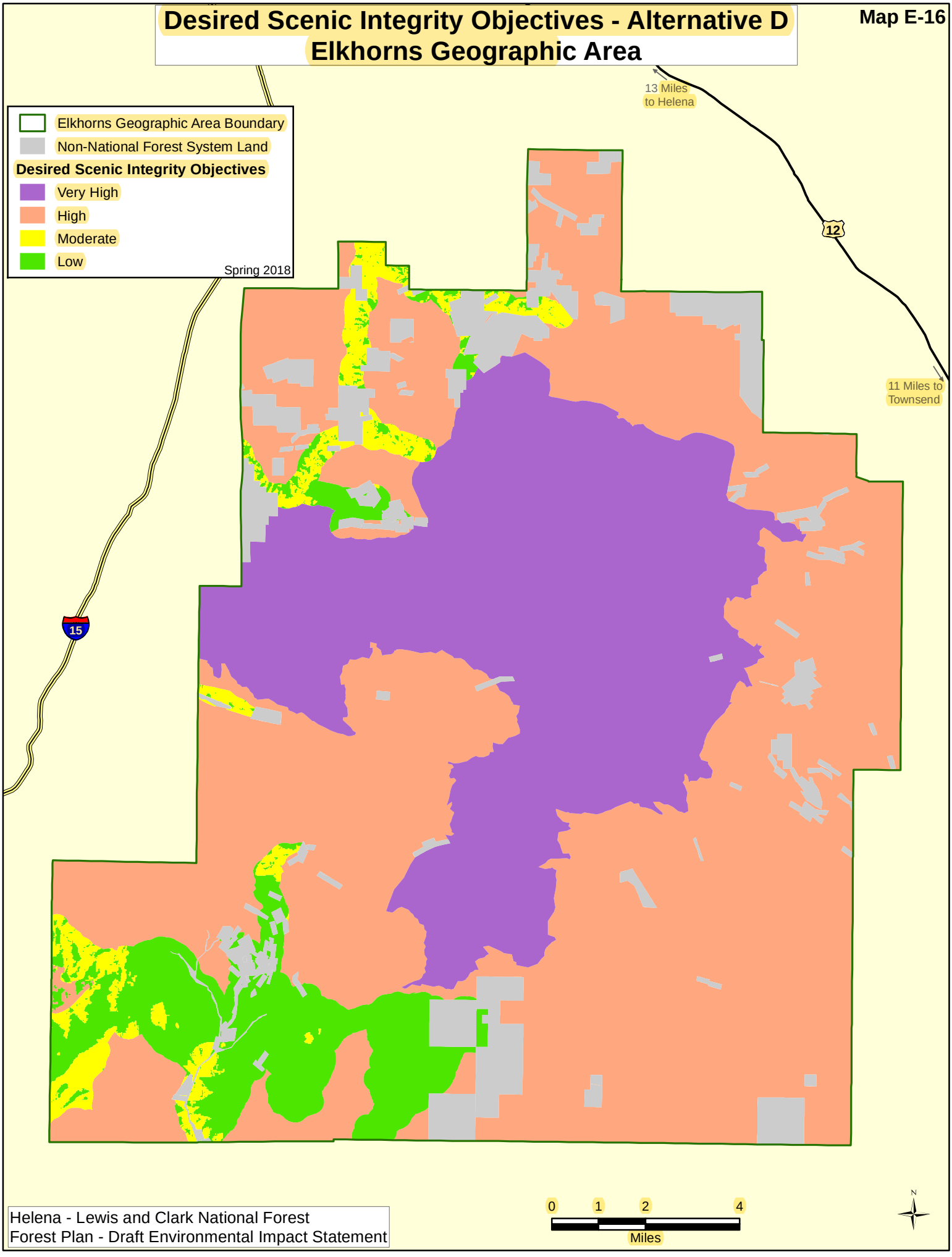
Map E-15



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Desired Scenic Integrity Objectives - Alternative D
Elkhorns Geographic Area

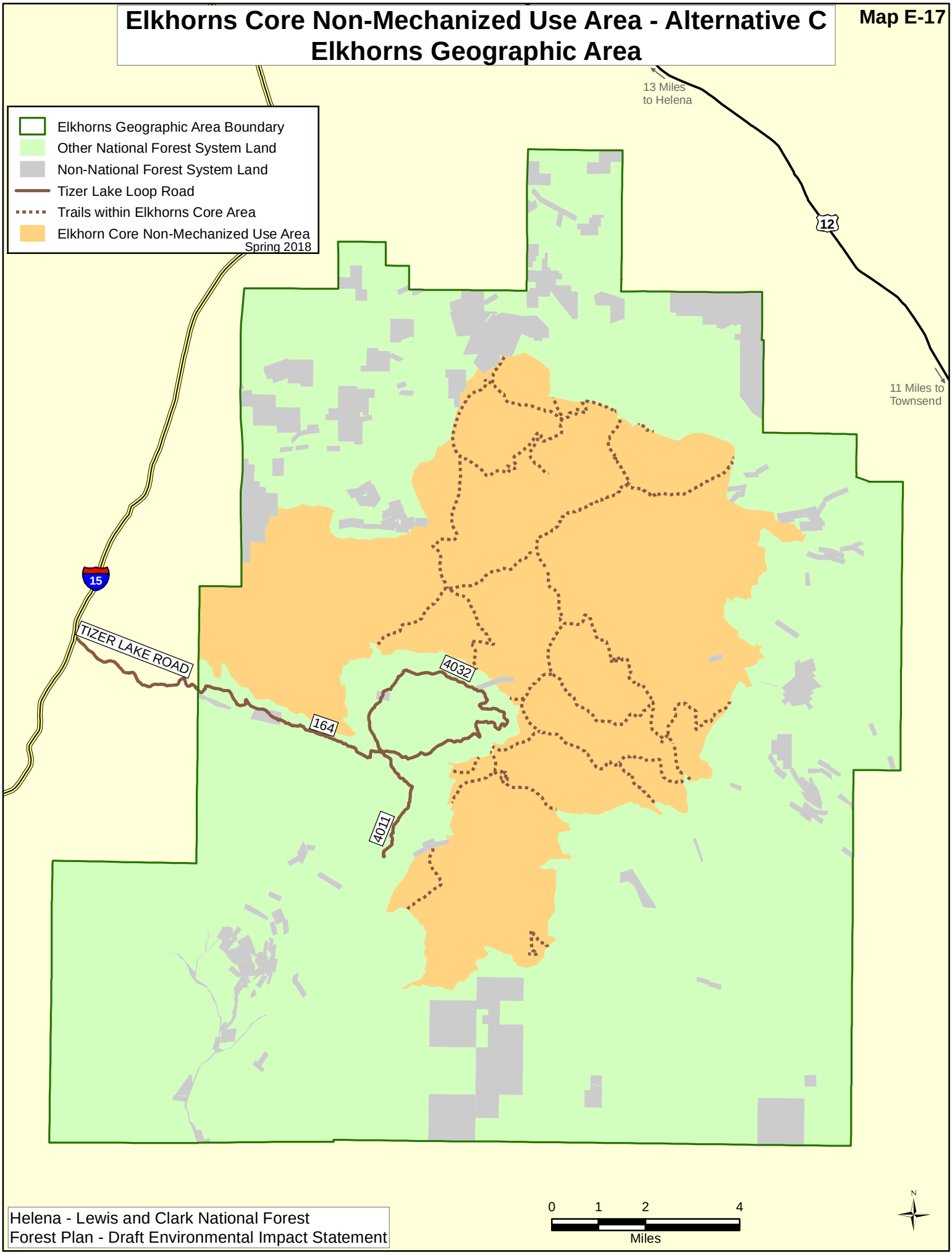
Map E-16



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Elkhorns Core Non-Mechanized Use Area - Alternative C
Elkhorns Geographic Area

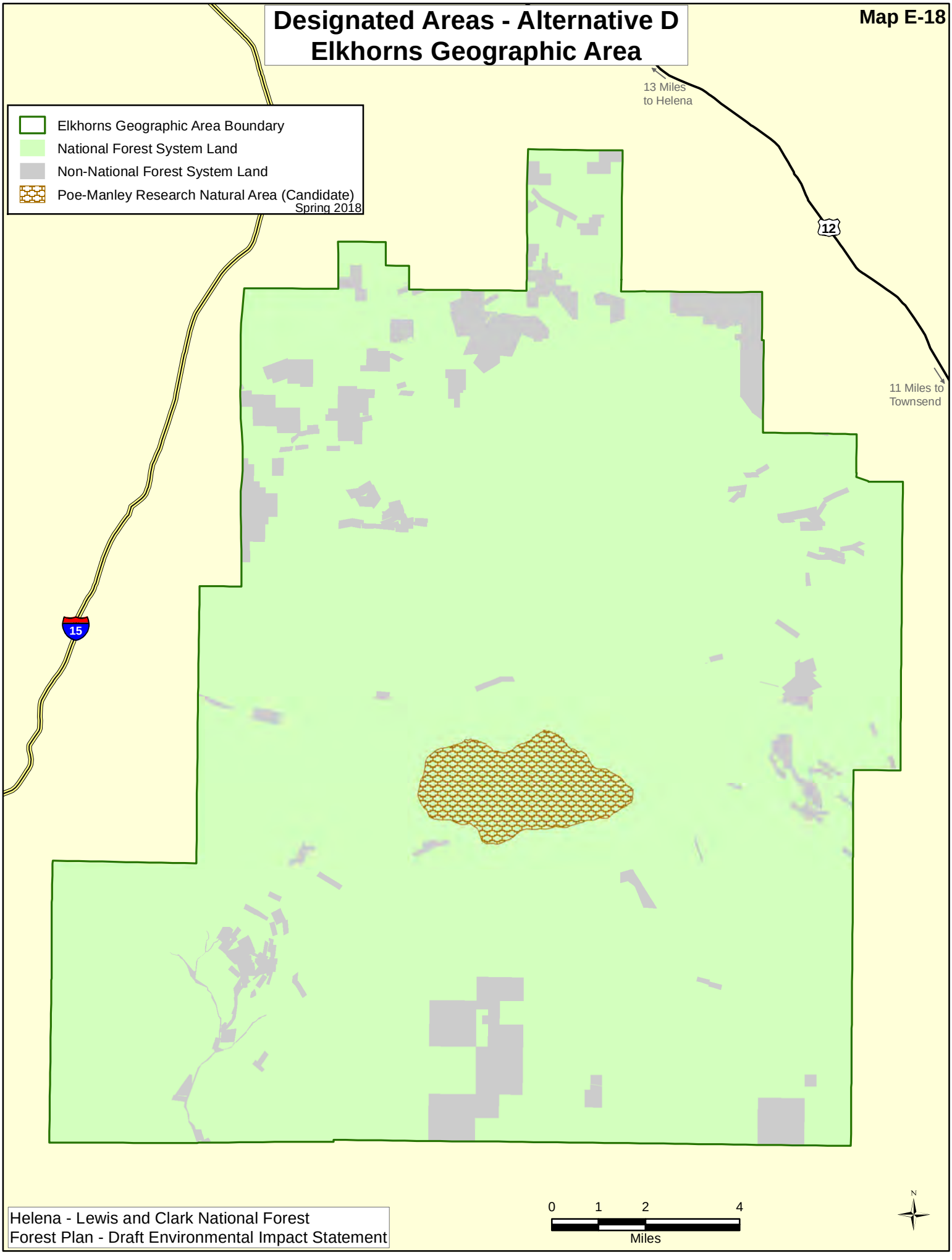
Map E-17



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Designated Areas - Alternative D
Elkhorns Geographic Area

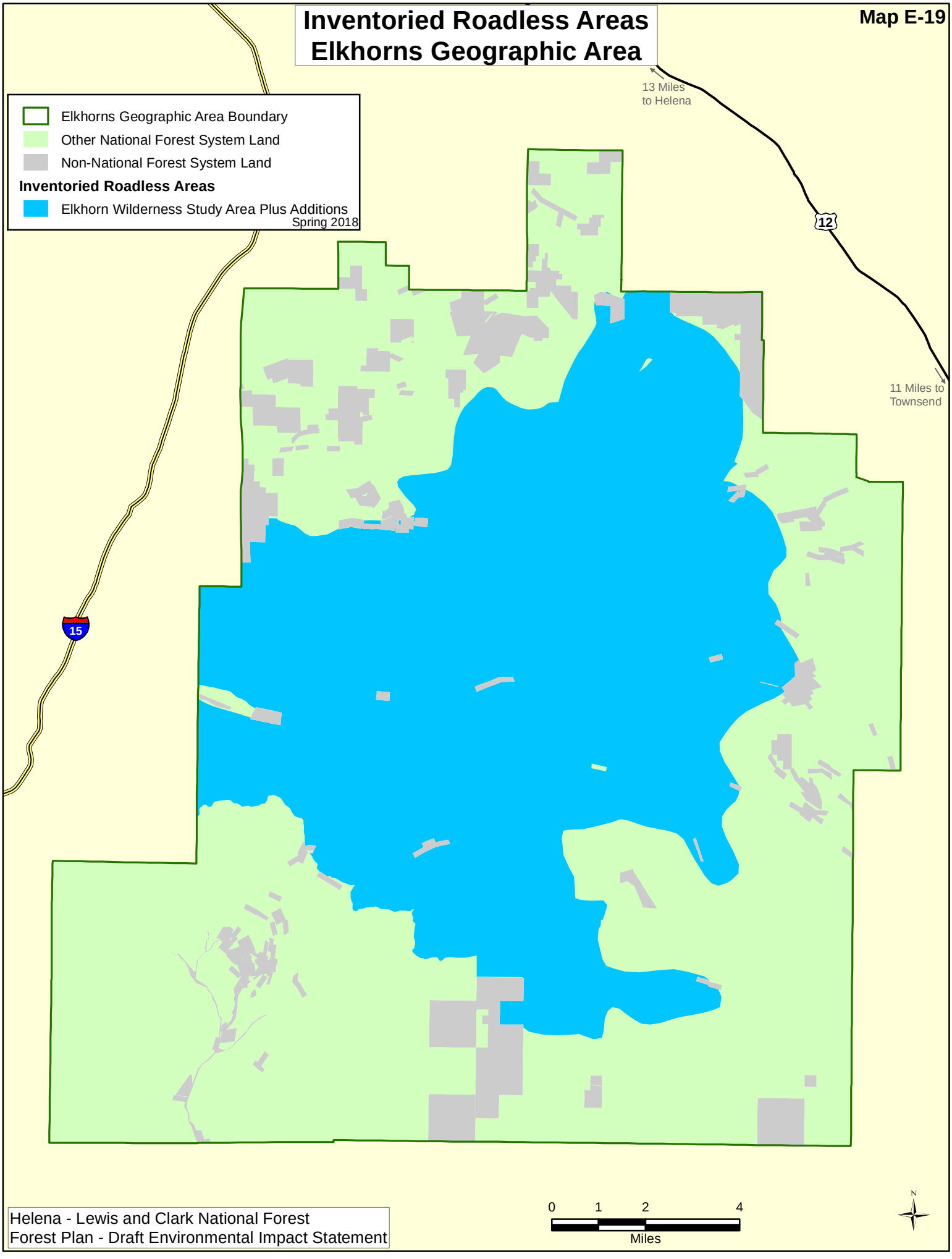
Map E-18



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Inventoried Roadless Areas
Elkhorns Geographic Area

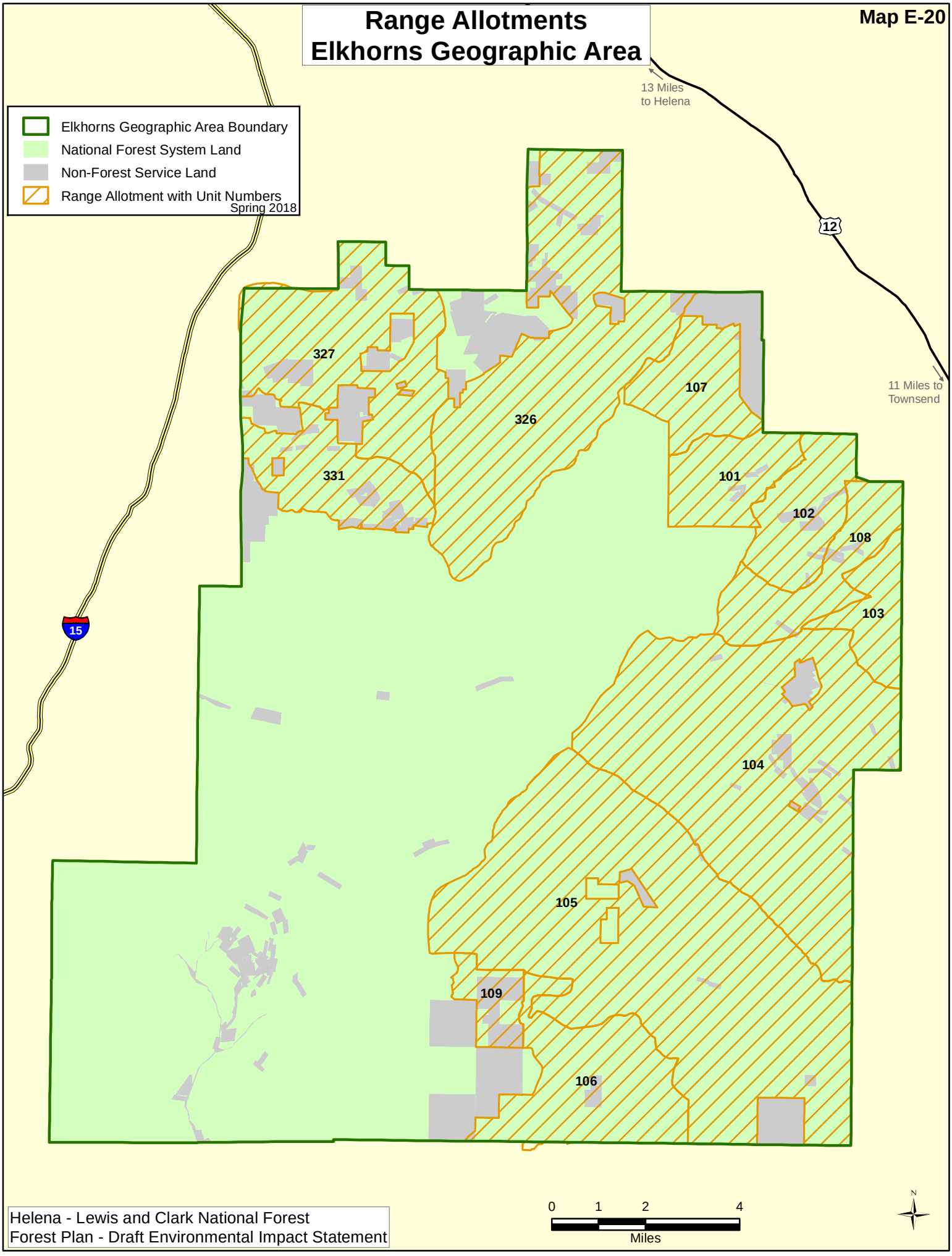
Map E-19



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Range Allotments
Elkhorns Geographic Area

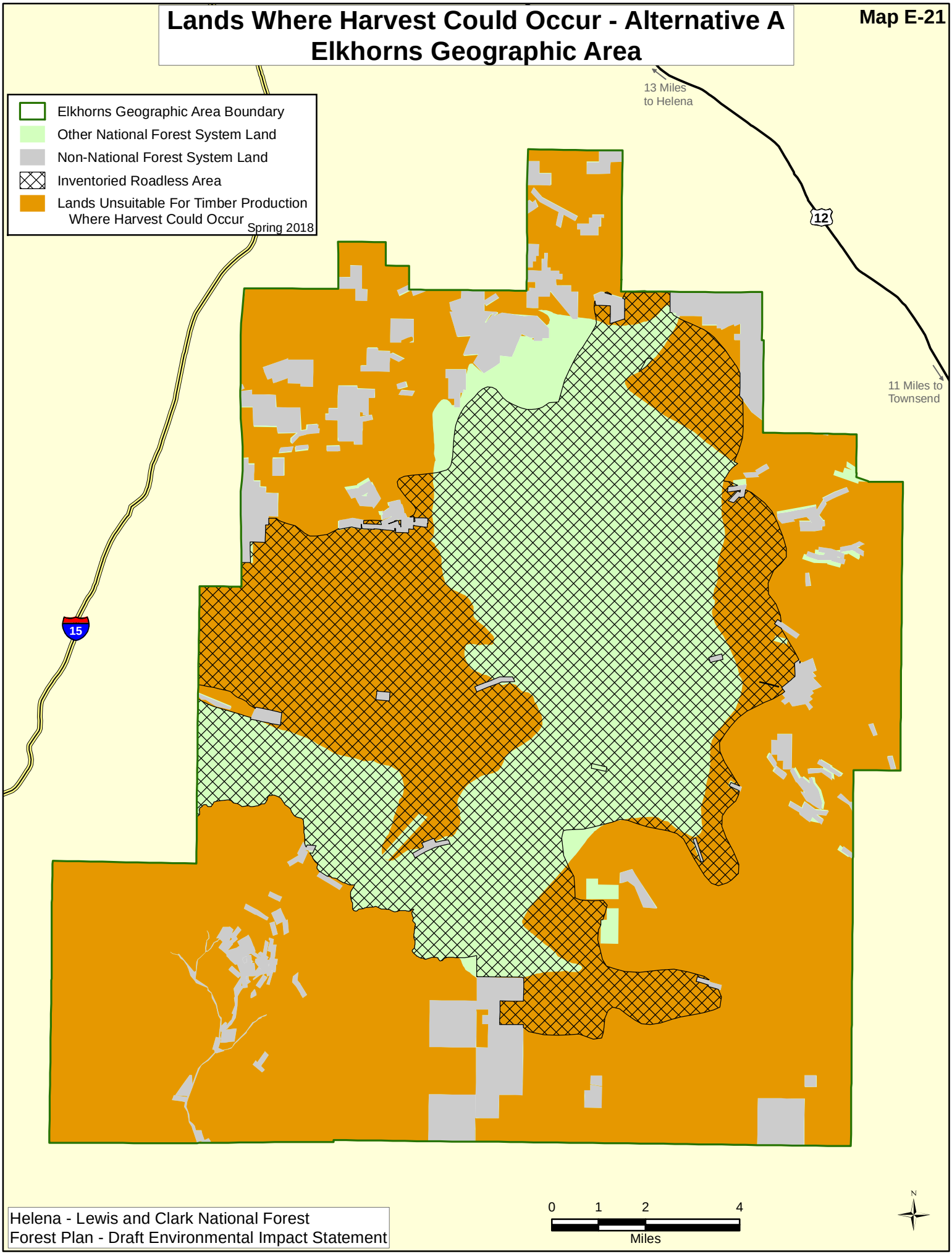
Map E-20



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Lands Where Harvest Could Occur - Alternative A
Elkhorns Geographic Area

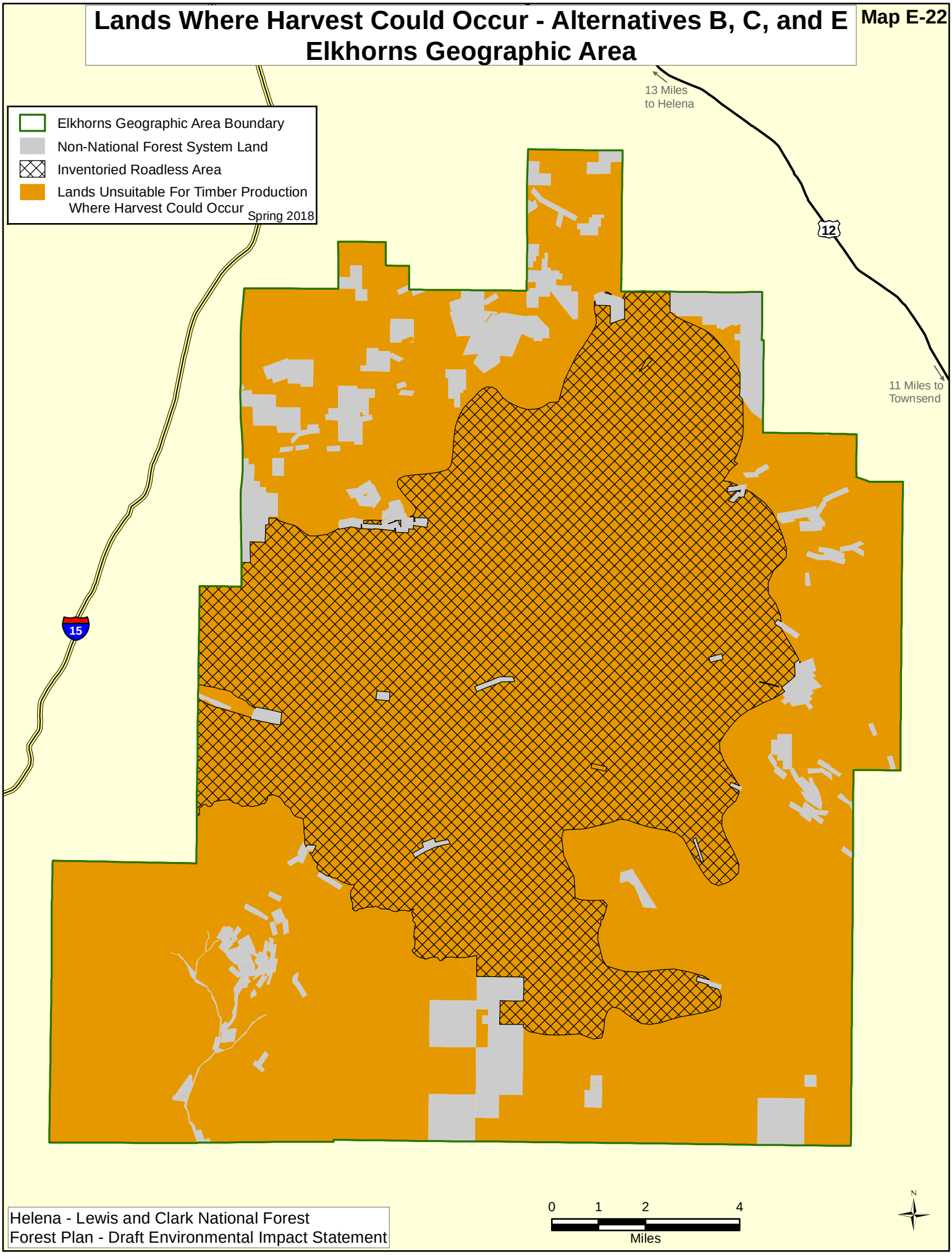
Map E-21



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Lands Where Harvest Could Occur - Alternatives B, C, and E
Elkhorns Geographic Area

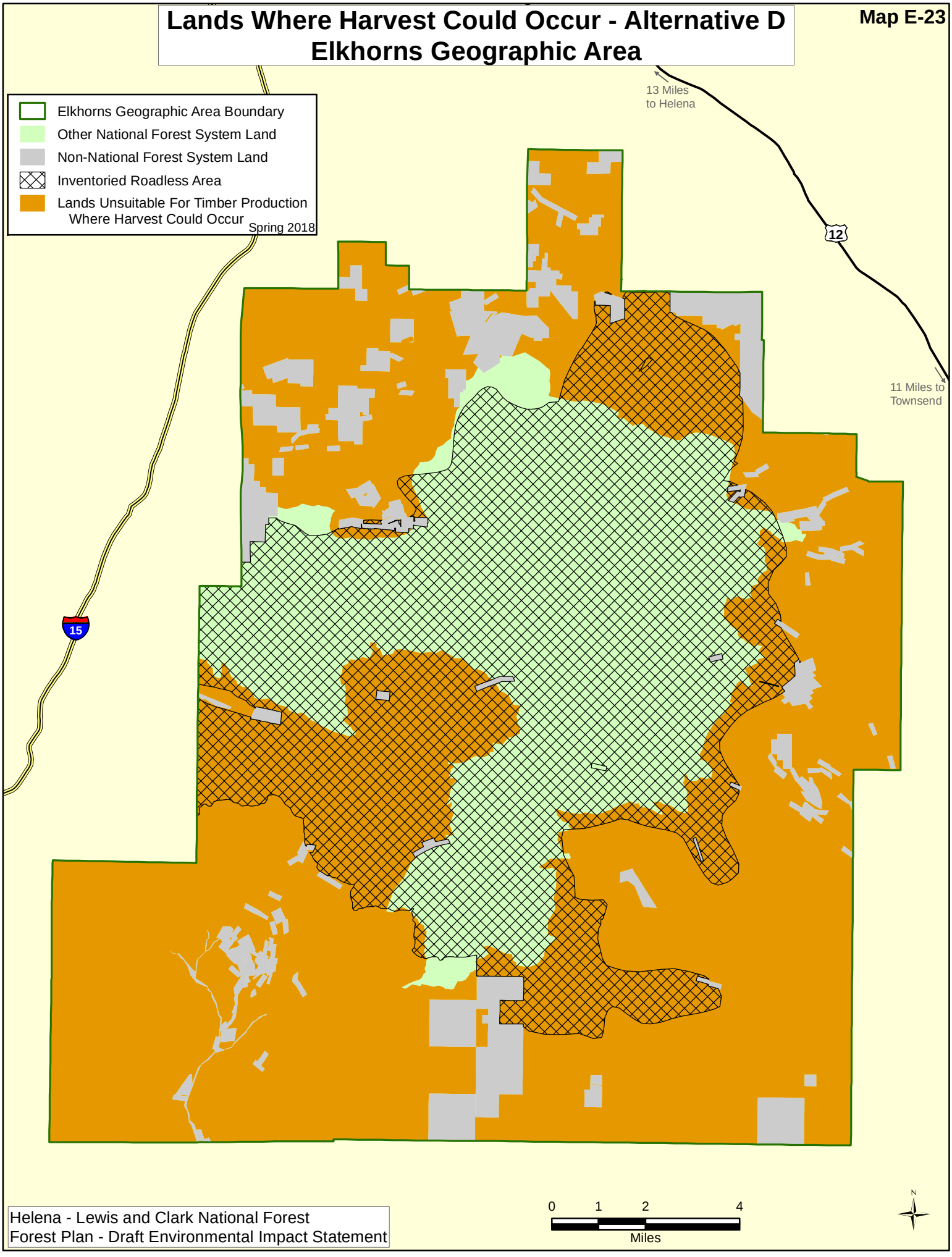
Map E-22



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Lands Where Harvest Could Occur - Alternative D
Elkhorns Geographic Area

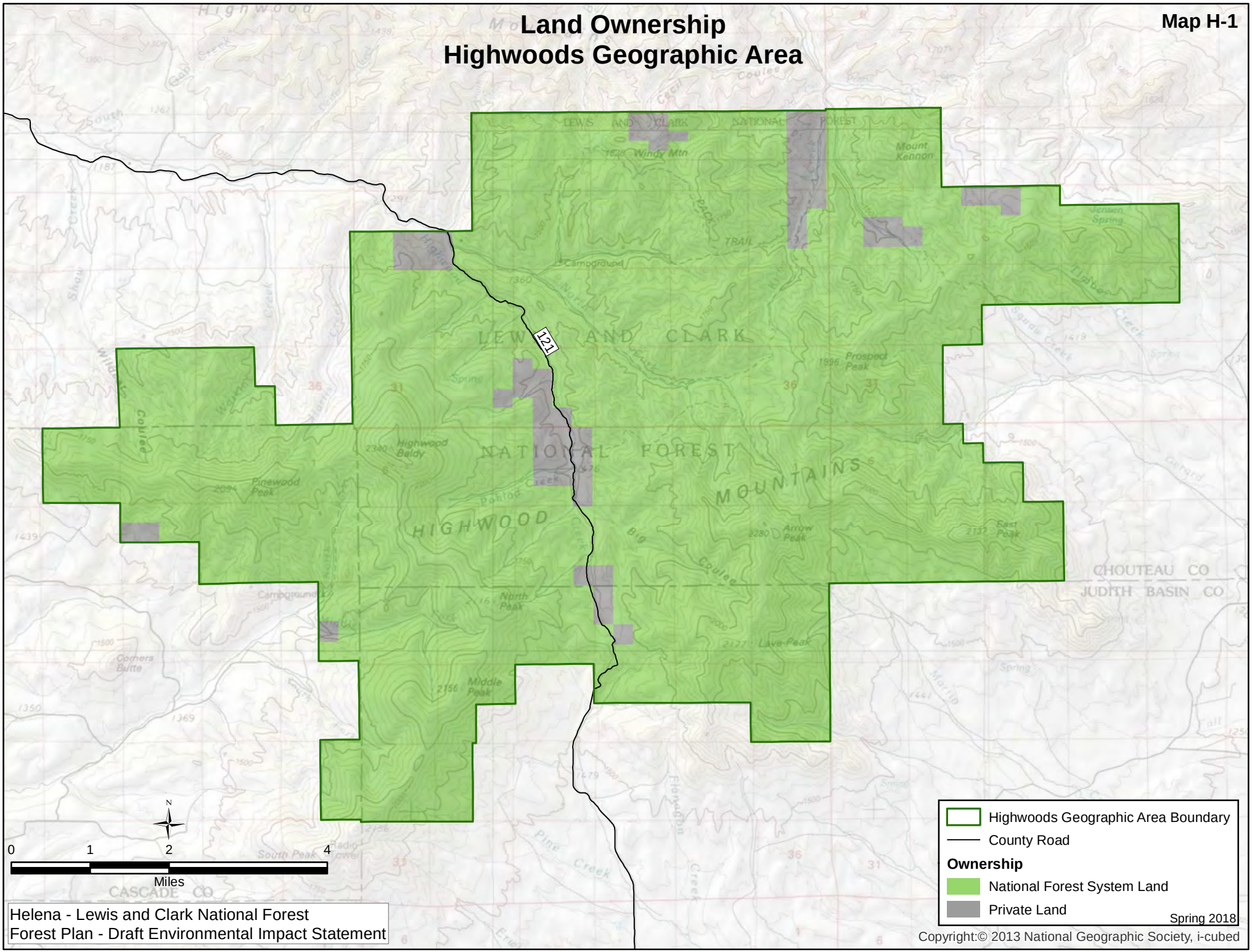
Map E-23



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Land Ownership
Highwoods Geographic Area

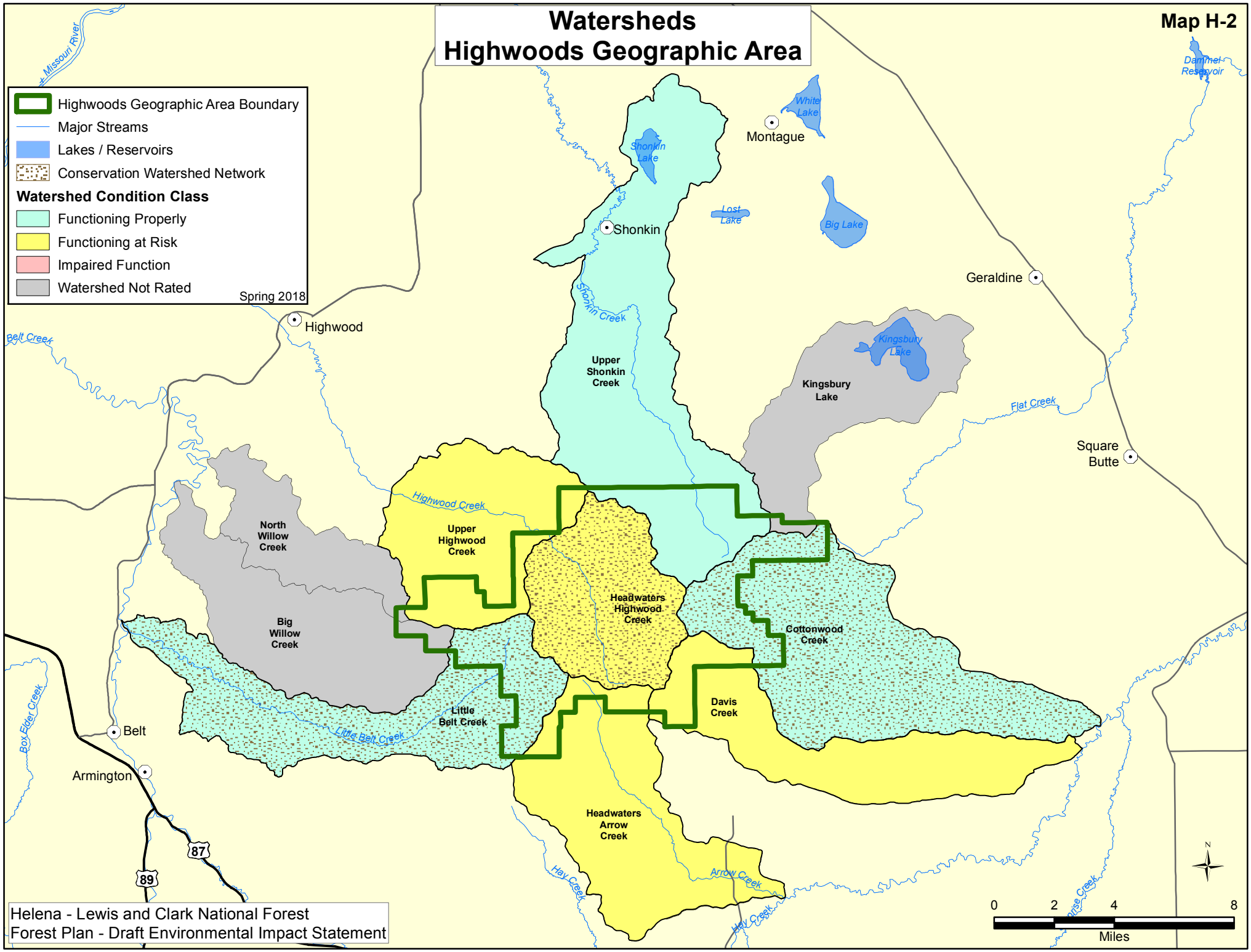
Map H-1



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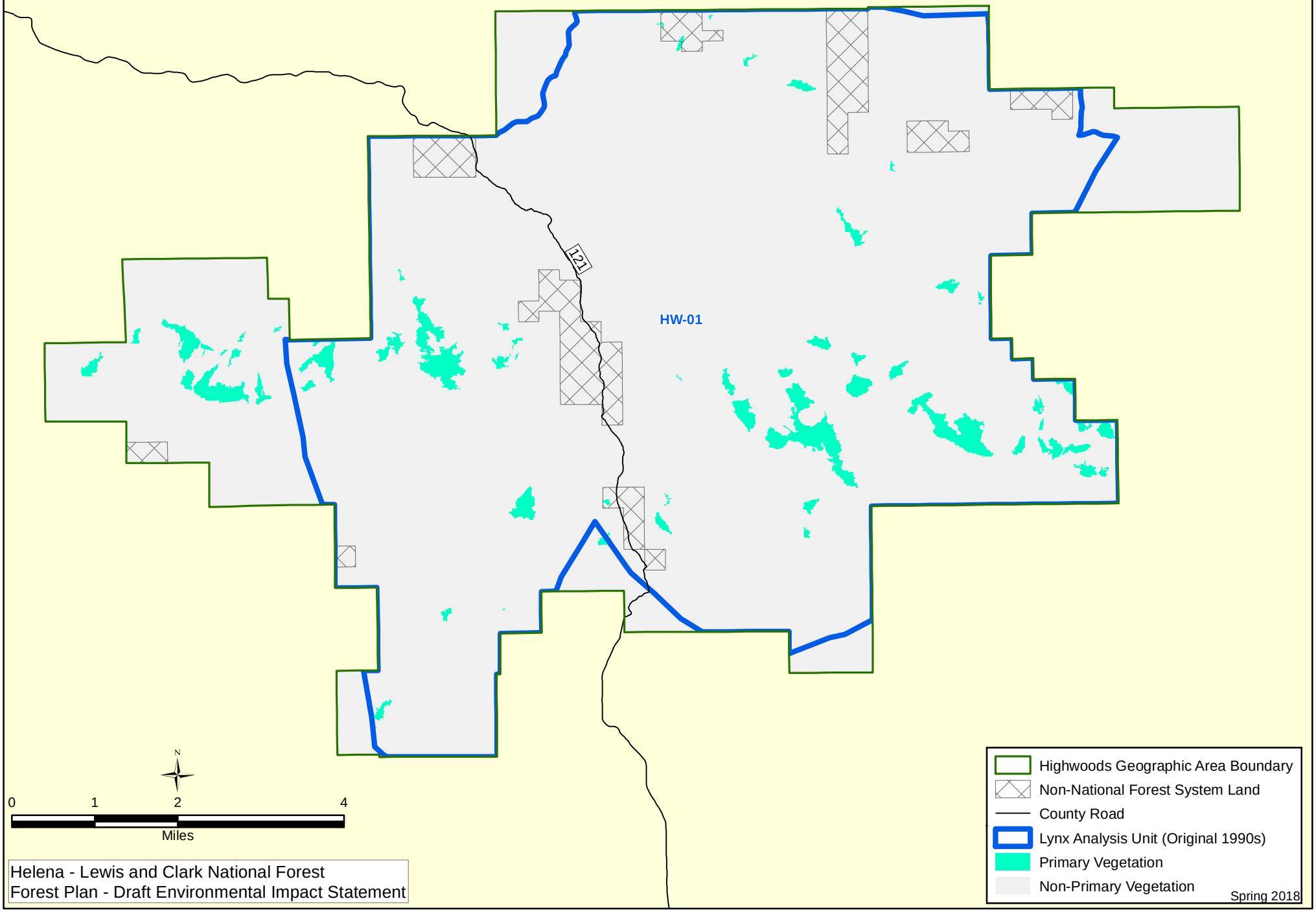
Spring 2018

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Watersheds
Highwoods Geographic Area
Map H-2
Highwoods Geographic Area Boundary
Major Streams
Lakes / Reservoirs
Conservation Watershed Network
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018
Missouri River
Belt Creek
Box Elder Creek
Highwood
Montague
White Lake
Shonkin Lake
Shonkin
Lost Lake
Big Lake
Geraldine
Shonkin Creek
Upper Shonkin Creek
Kingsbury Lake
Kingsbury Lake
Flat Creek
Square Butte
Dammel Reservoir
Highwood Creek
North Willow Creek
Upper Highwood Creek
Headwaters Highwood Creek
Cottonwood Creek
Big Willow Creek
Little Belt Creek
Little Belt Creek
Davis Creek
Belt
Armington
Headwaters Arrow Creek
Arrow Creek
Hay Creek
Hay Creek
87
89
0
2
4
8
Miles
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Lynx Analysis Units
Highwoods Geographic Area

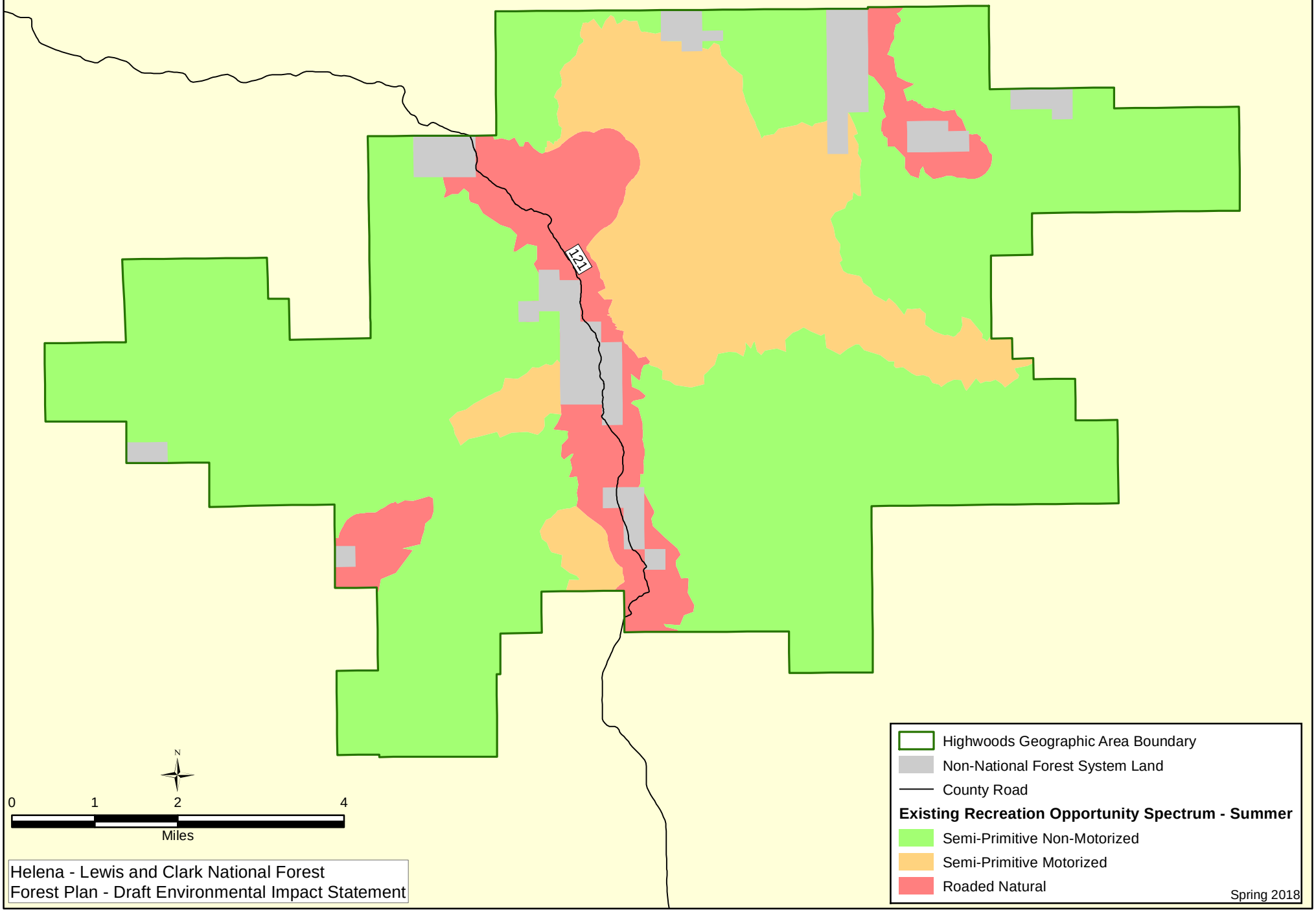
Map H-3



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Existing Summer Recreation Opportunity Spectrum - Alternative A
Highwoods Geographic Area

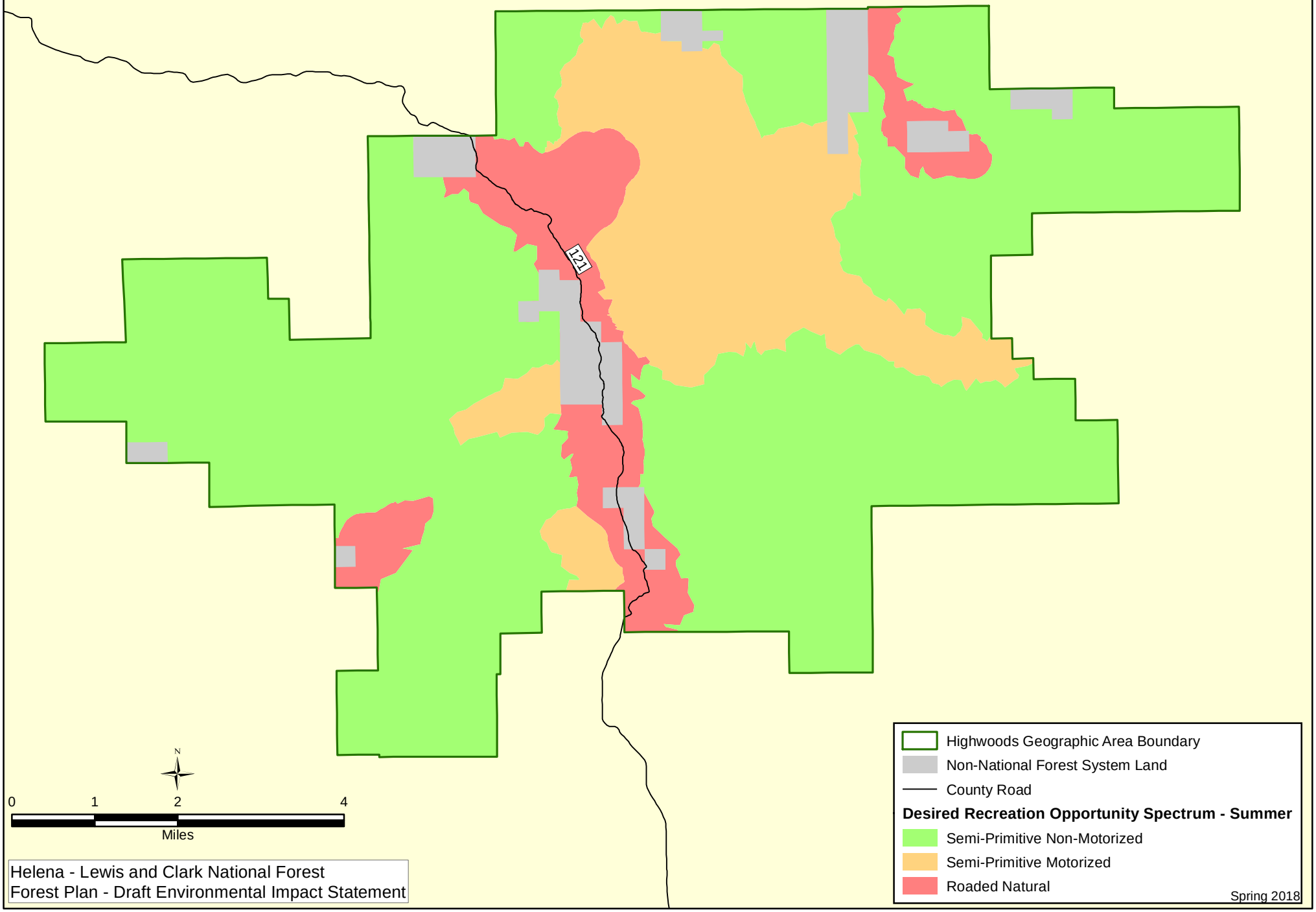
Map H-4



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Desired Summer Recreation Opportunity Spectrum - Alternatives B and C
Highwoods Geographic Area

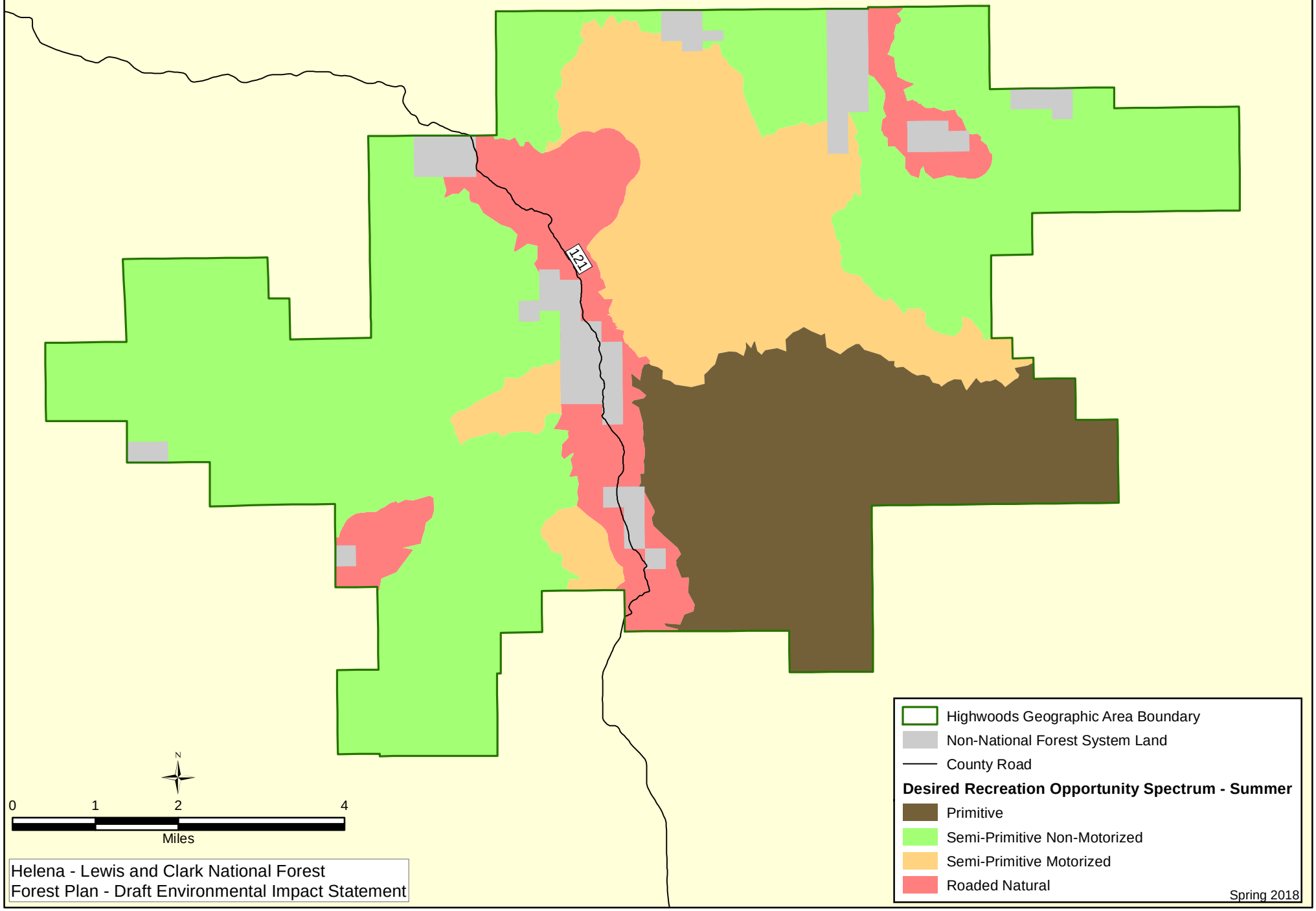
Map H-5



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Highwoods Geographic Area

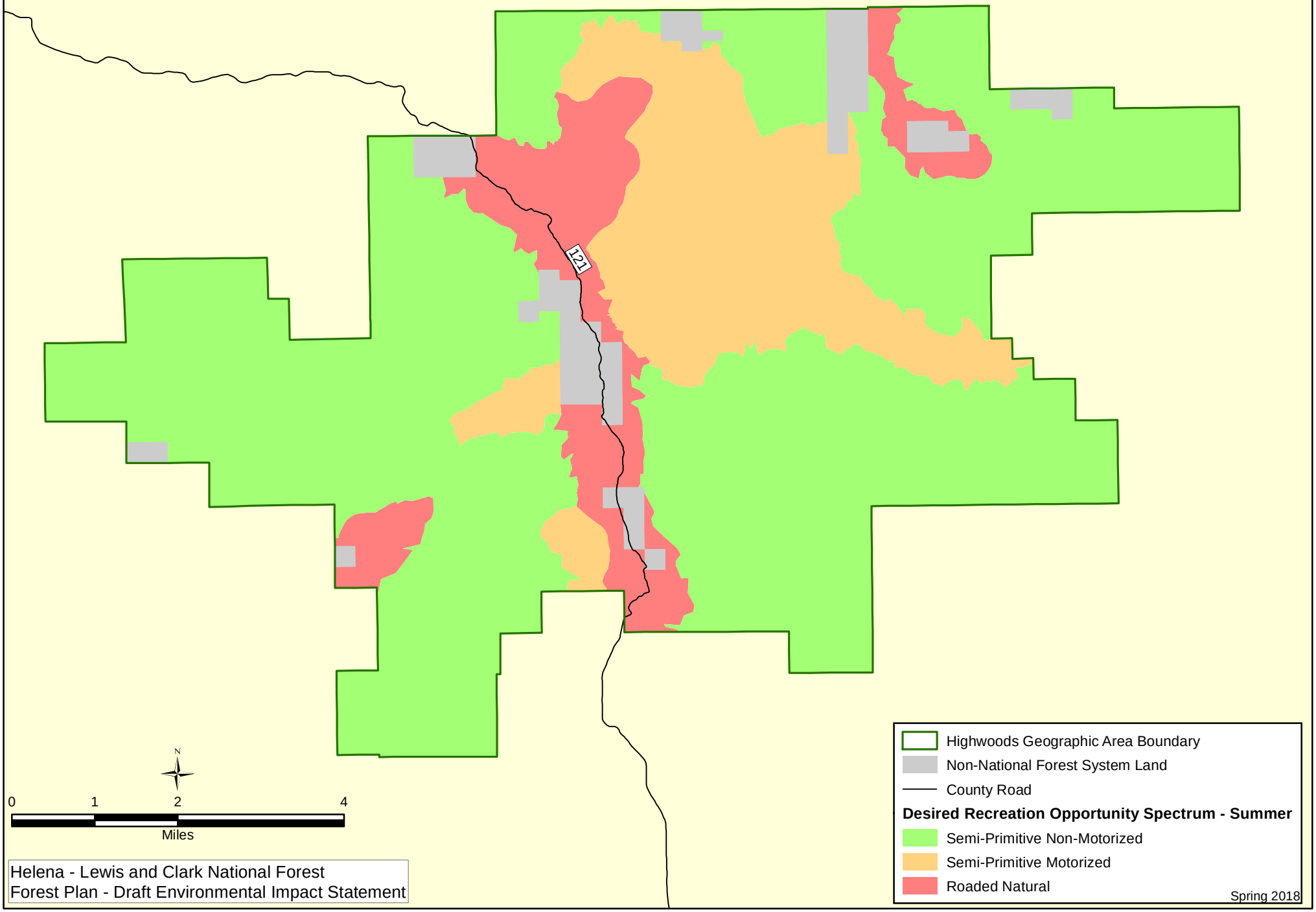
Map H-6



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Desired Summer Recreation Opportunity Spectrum - Alternative E
Highwoods Geographic Area

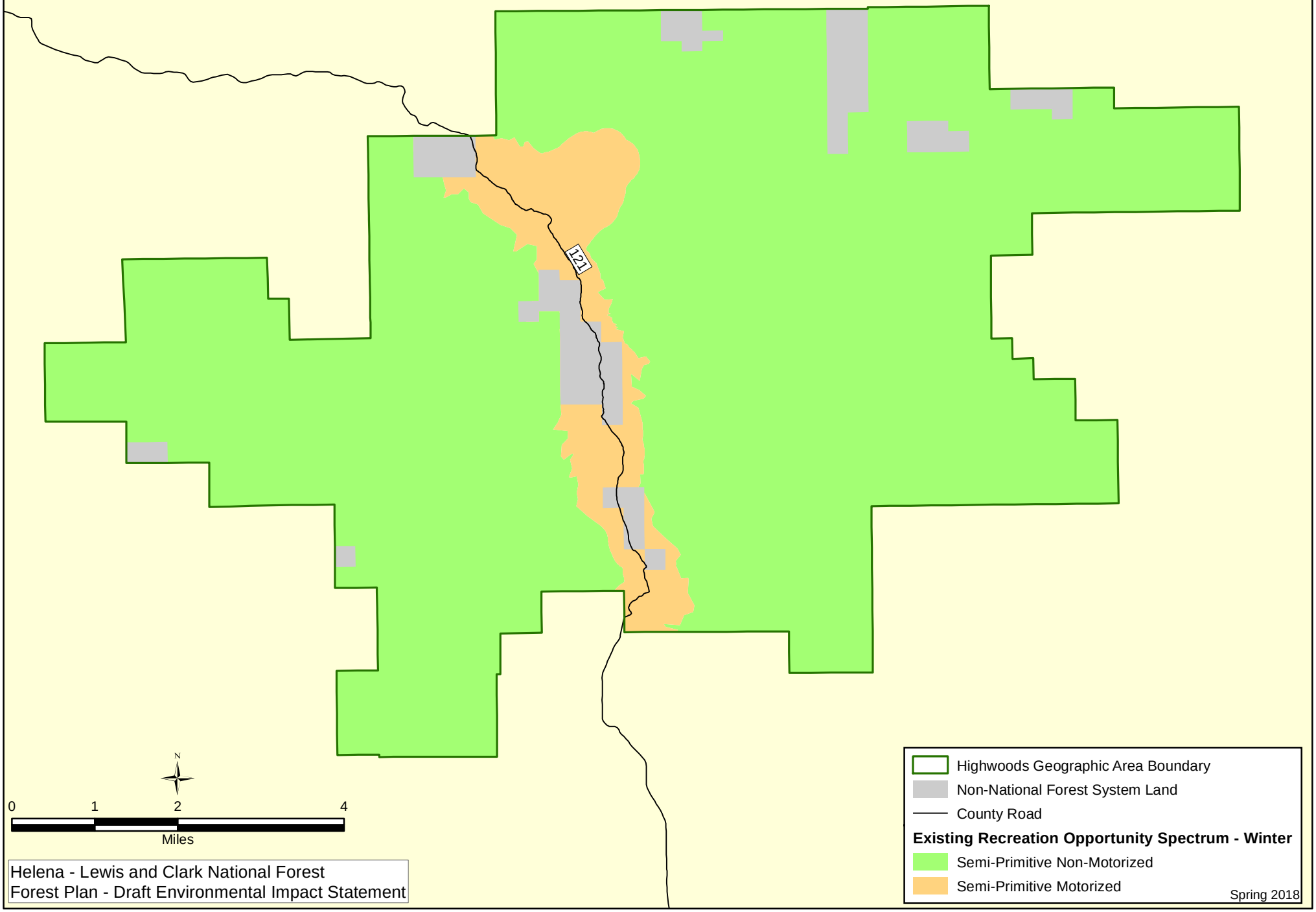
Map H-7



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Highwoods Geographic Area

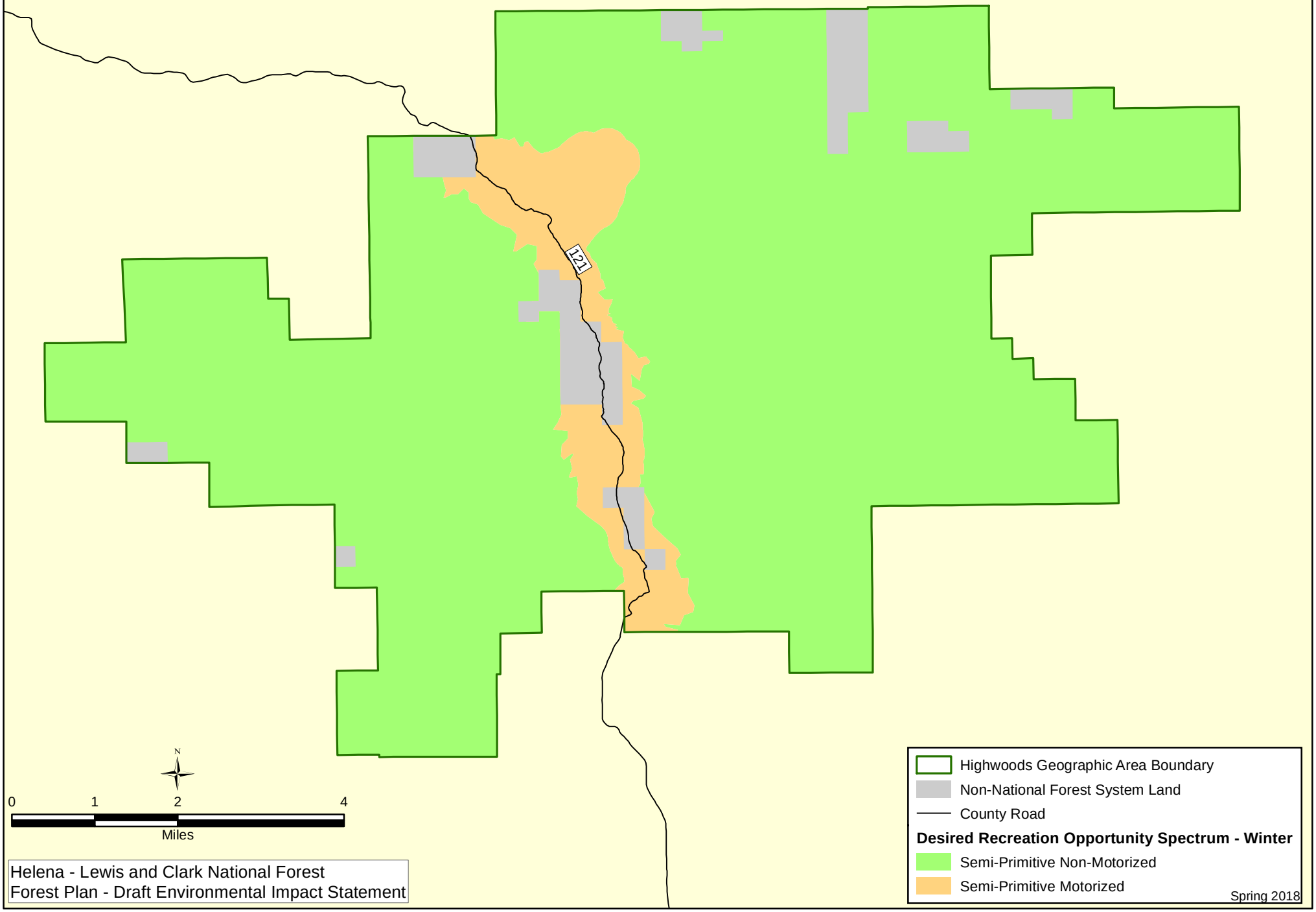
Map H-8



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Desired Winter Recreation Opportunity Spectrum - Alternatives B and C
Highwoods Geographic Area

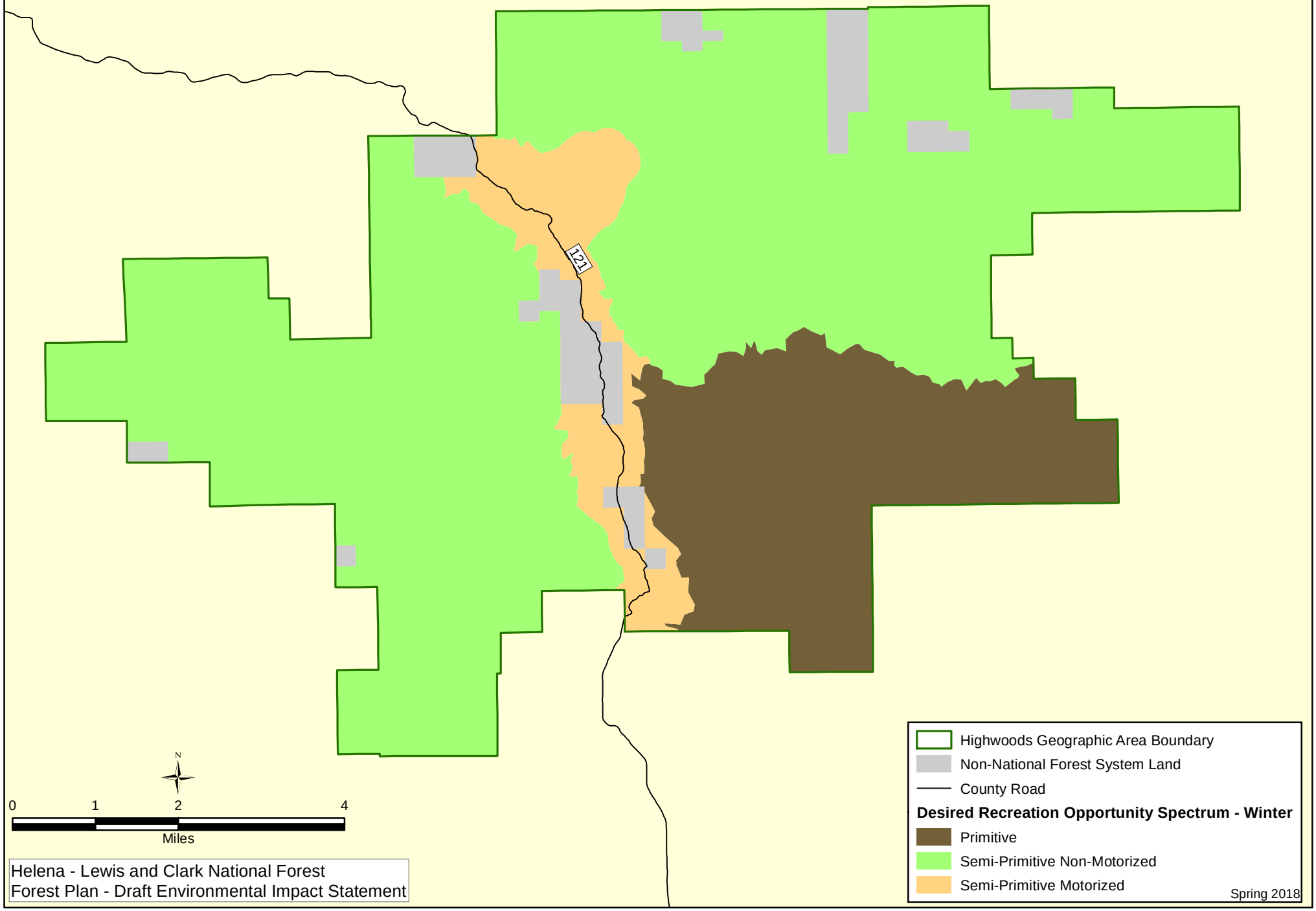
Map H-9



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Desired Winter Recreation Opportunity Spectrum - Alternative D
Highwoods Geographic Area

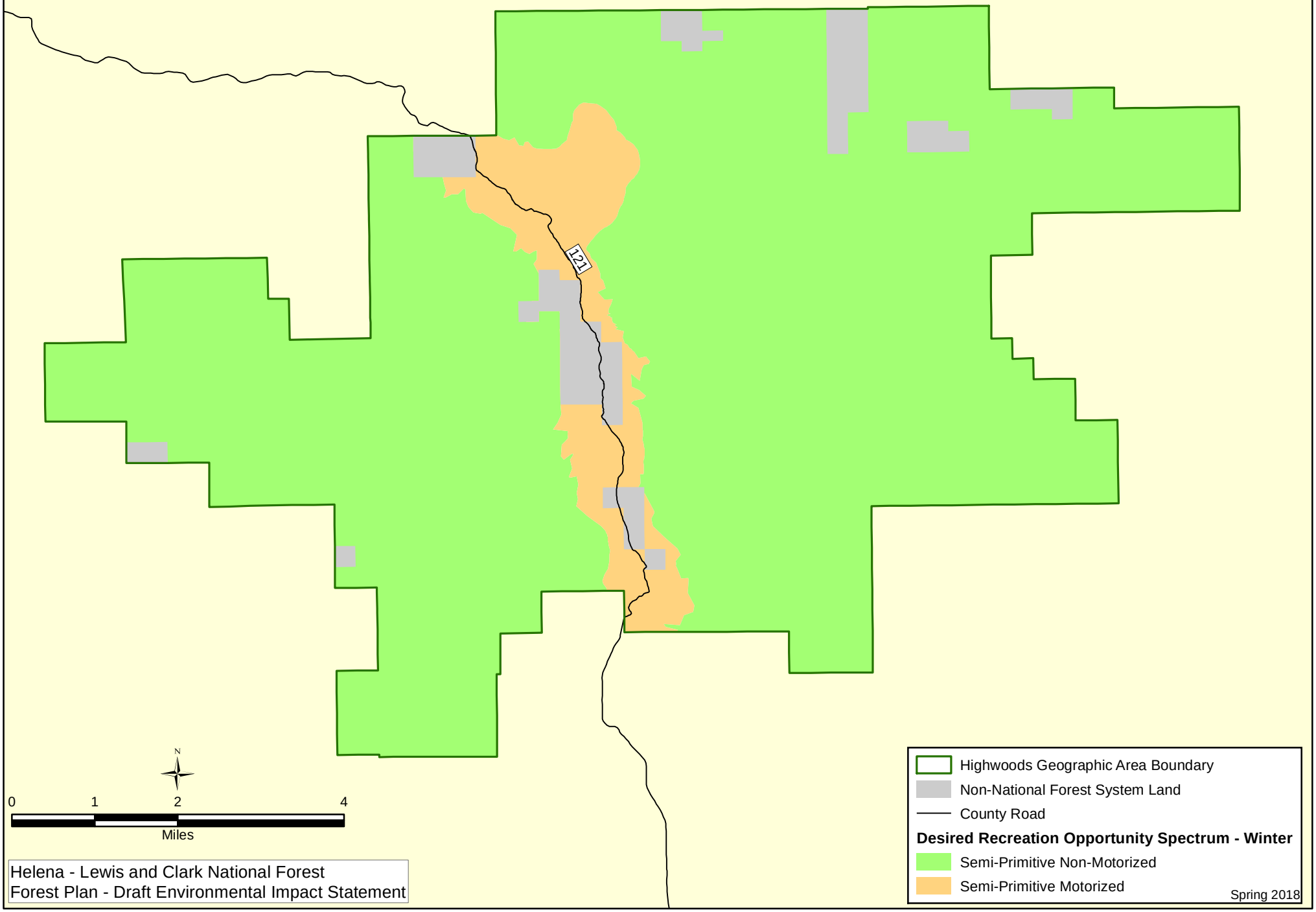
Map H-10



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Desired Winter Recreation Opportunity Spectrum - Alternative E
Highwoods Geographic Area

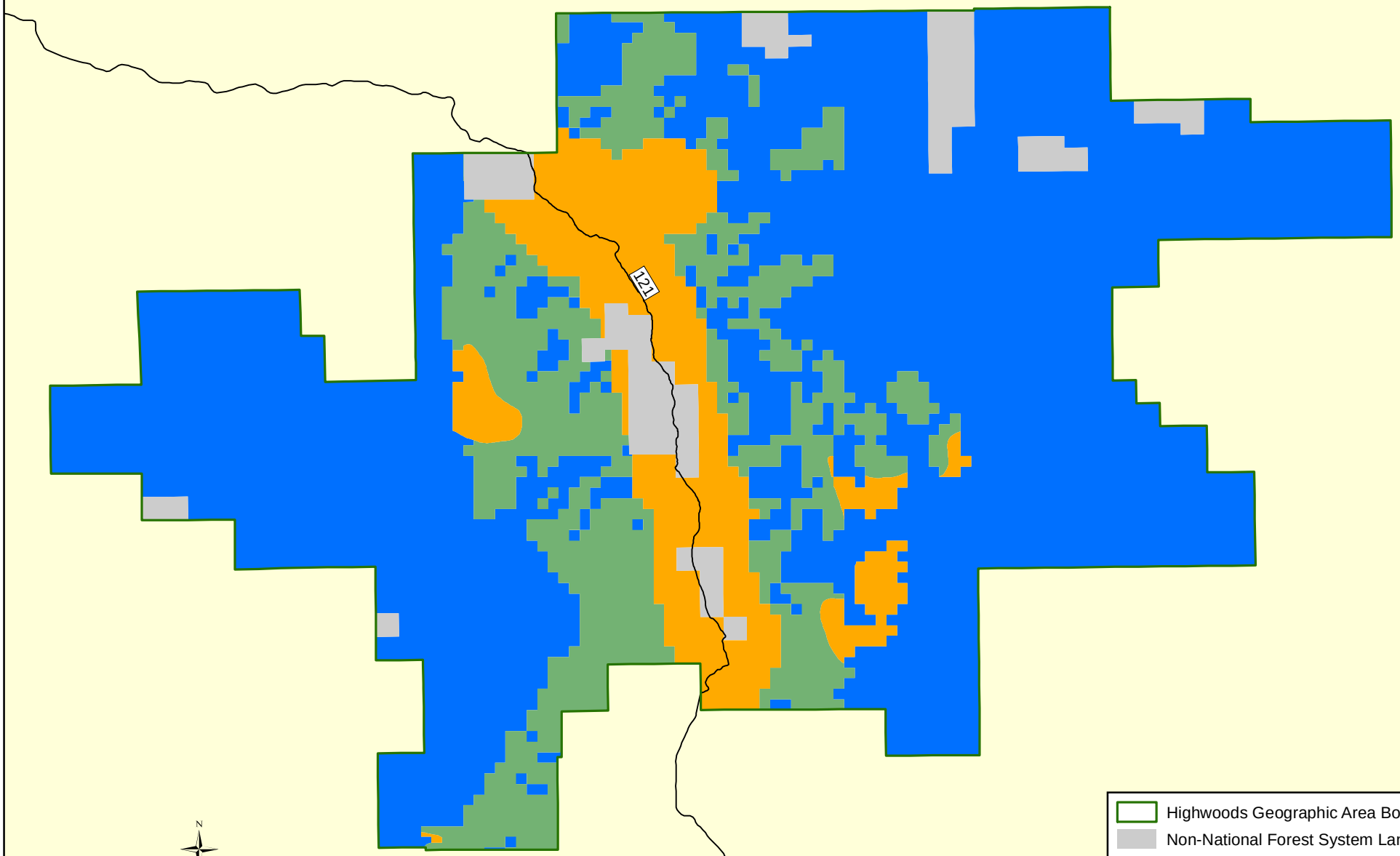
Map H-11



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Visual Quality Objectives - Alternative A
Highwoods Geographic Area

Map H-12



N

0 1 2 4

Miles

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Highwoods Geographic Area Boundary
Non-National Forest System Land
County Road

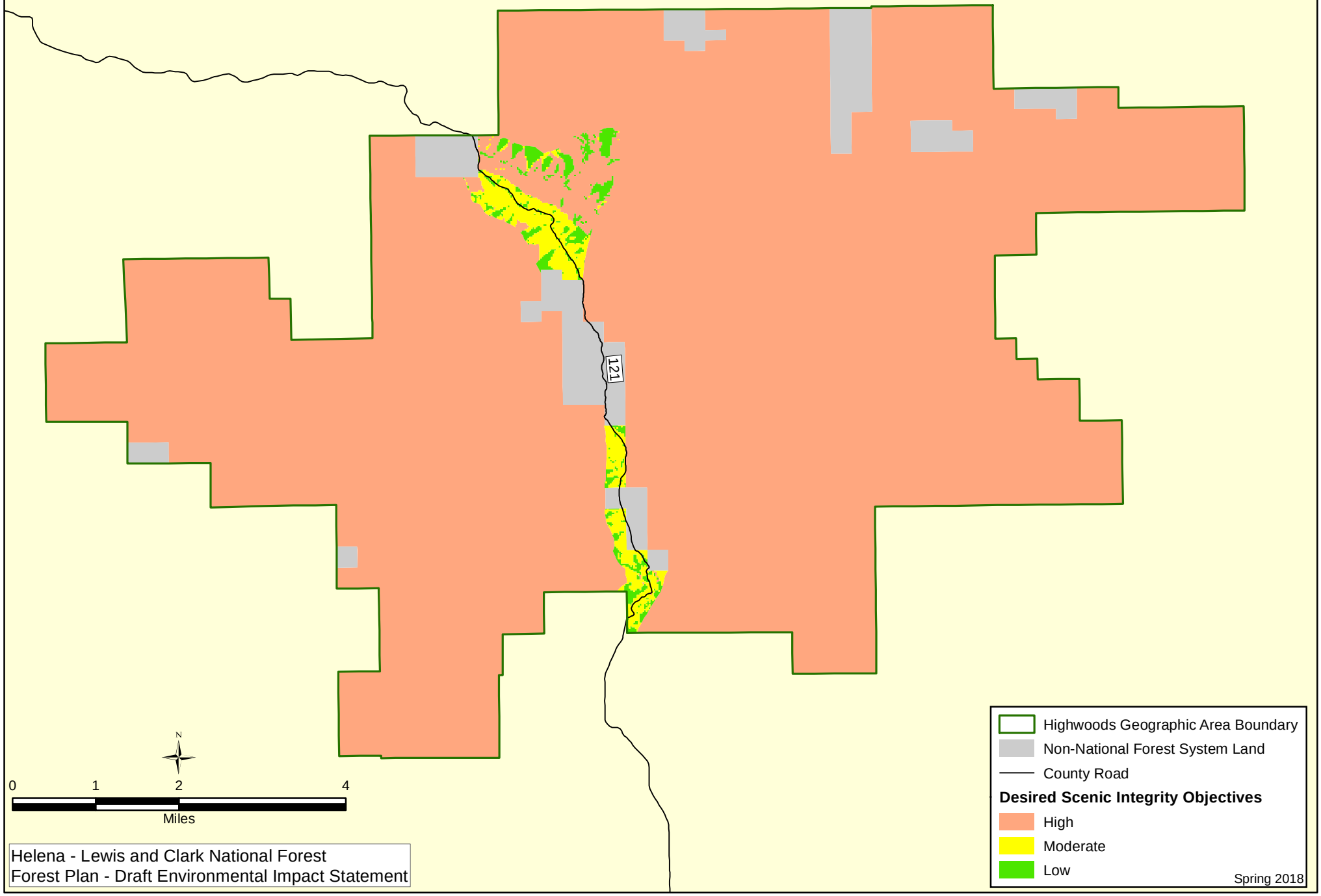
Visual Quality Objectives

Retention
Partial Retention
Modification

Spring 2018

Desired Scenic Integrity Objectives - Alternative B
Highwoods Geographic Area

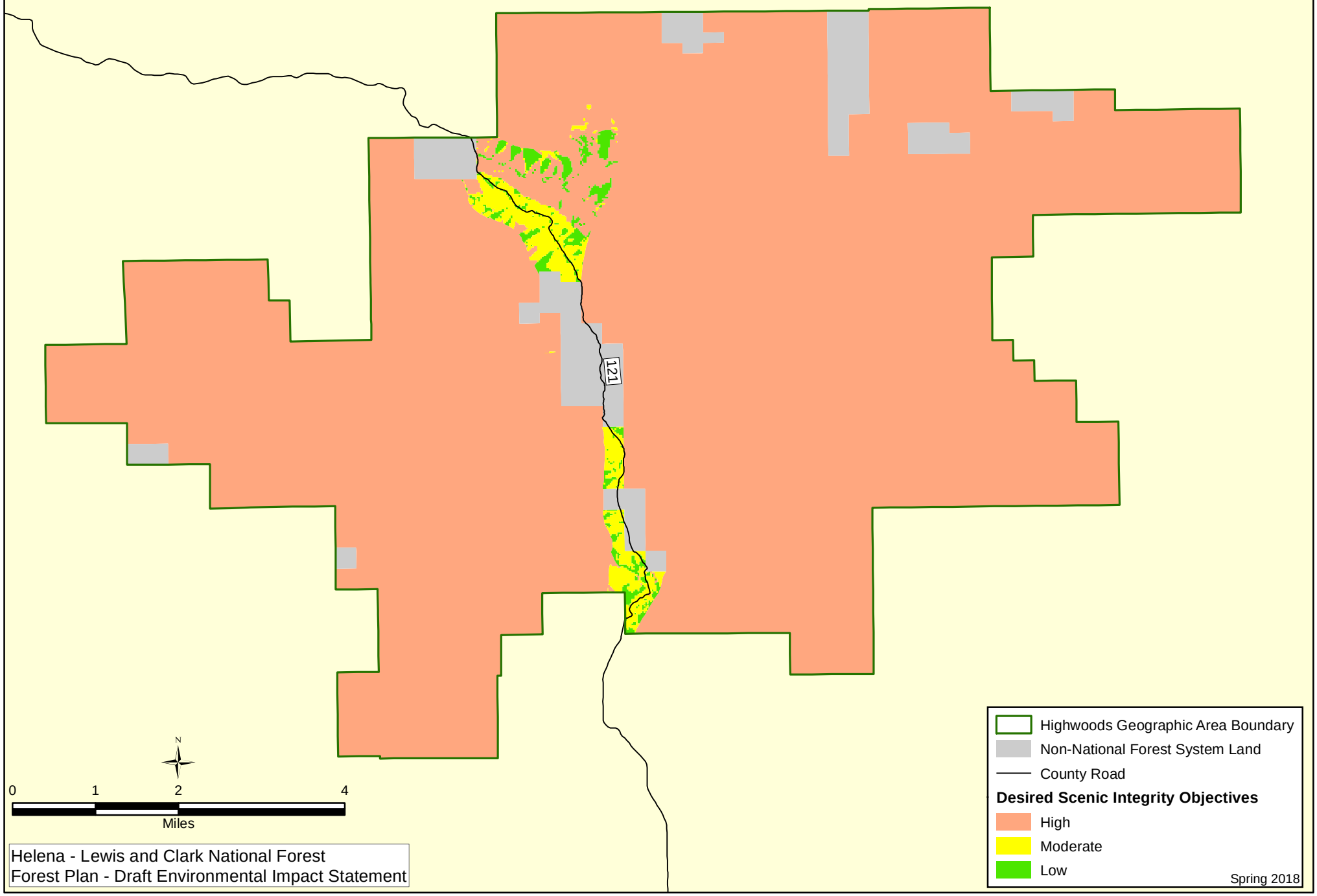
Map H-13



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Desired Scenic Integrity Objectives - Alternative C
Highwoods Geographic Area

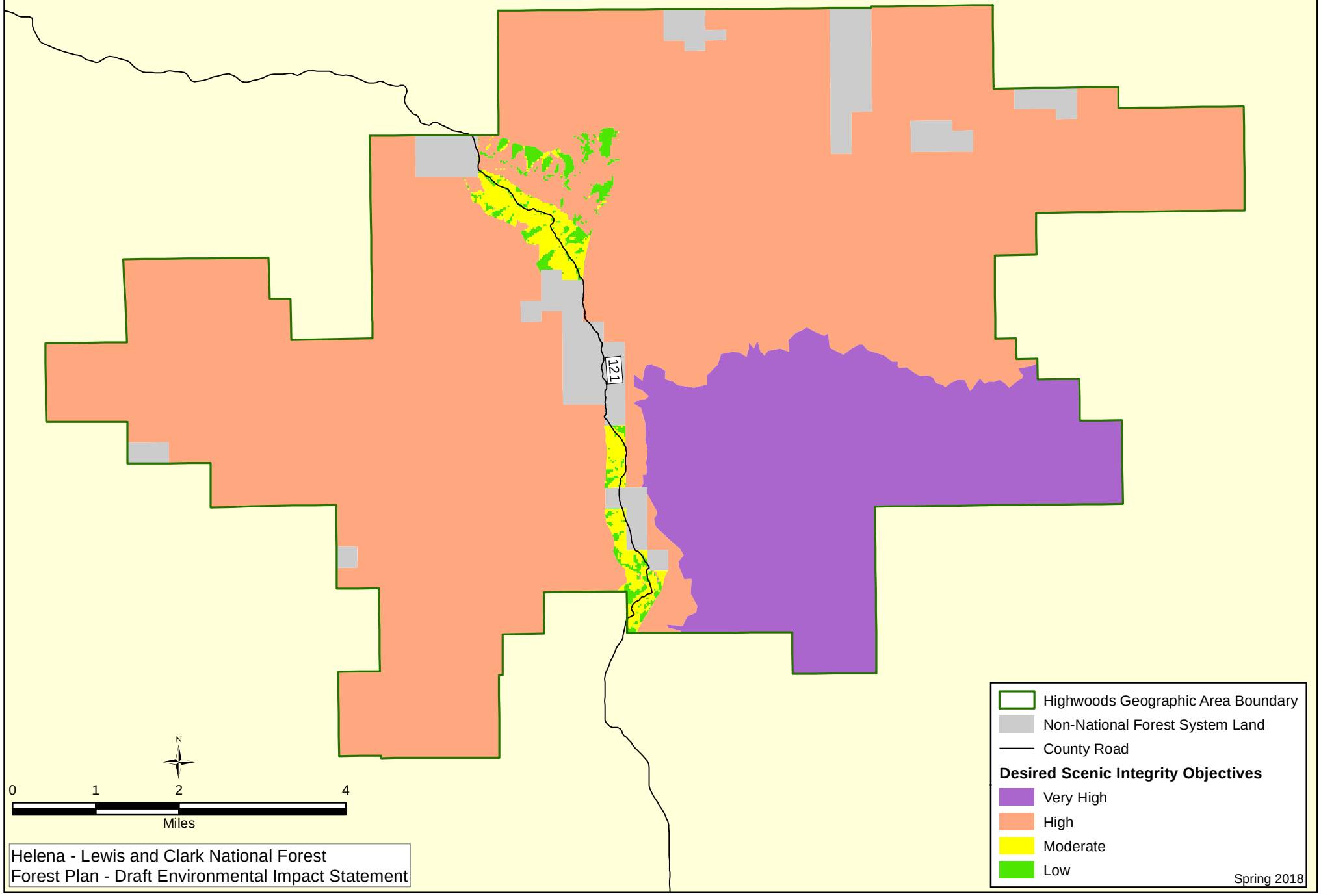
Map H-14



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Desired Scenic Integrity Objectives - Alternative D
Highwoods Geographic Area

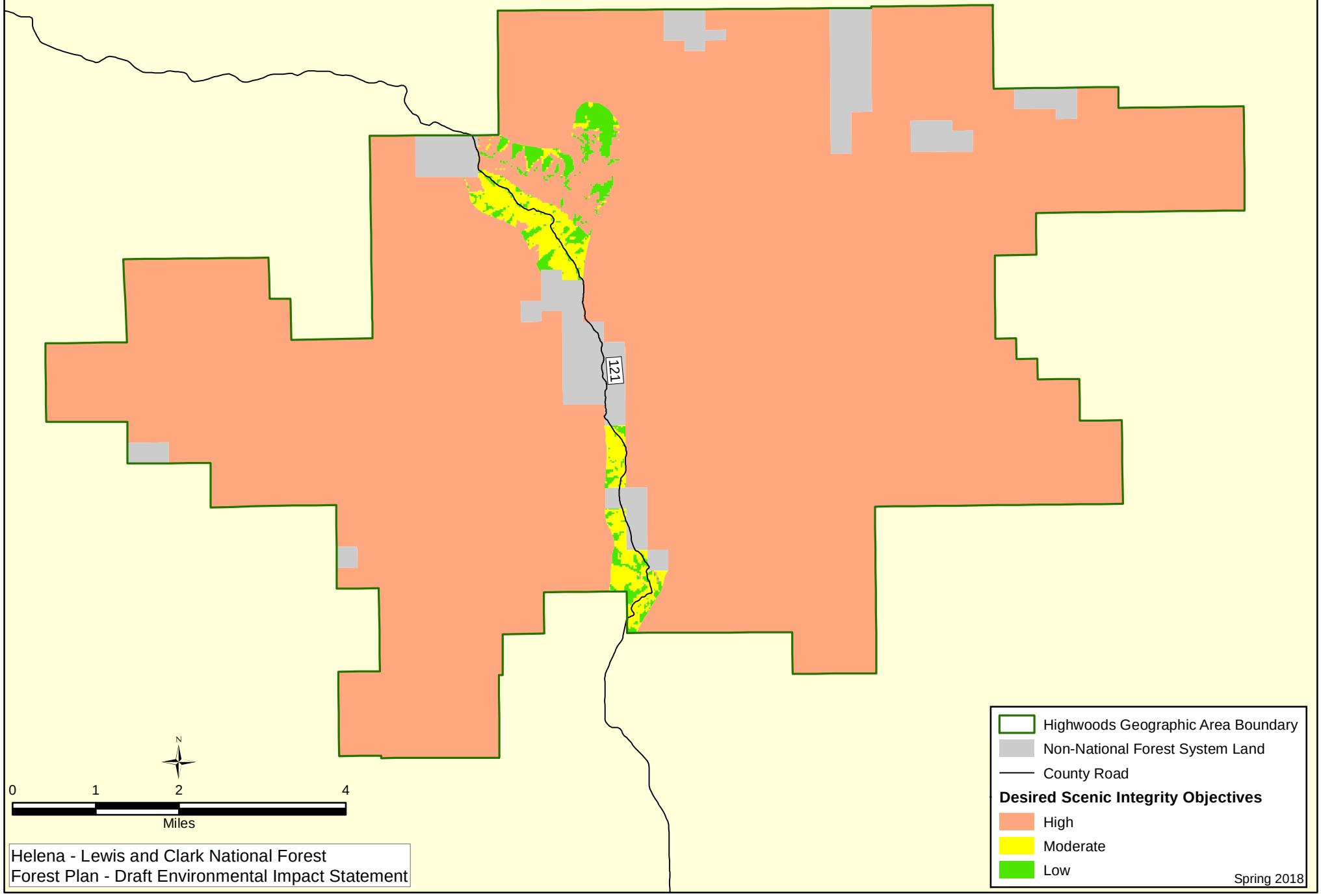
Map H-15



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Desired Scenic Integrity Objectives - Alternative E
Highwoods Geographic Area

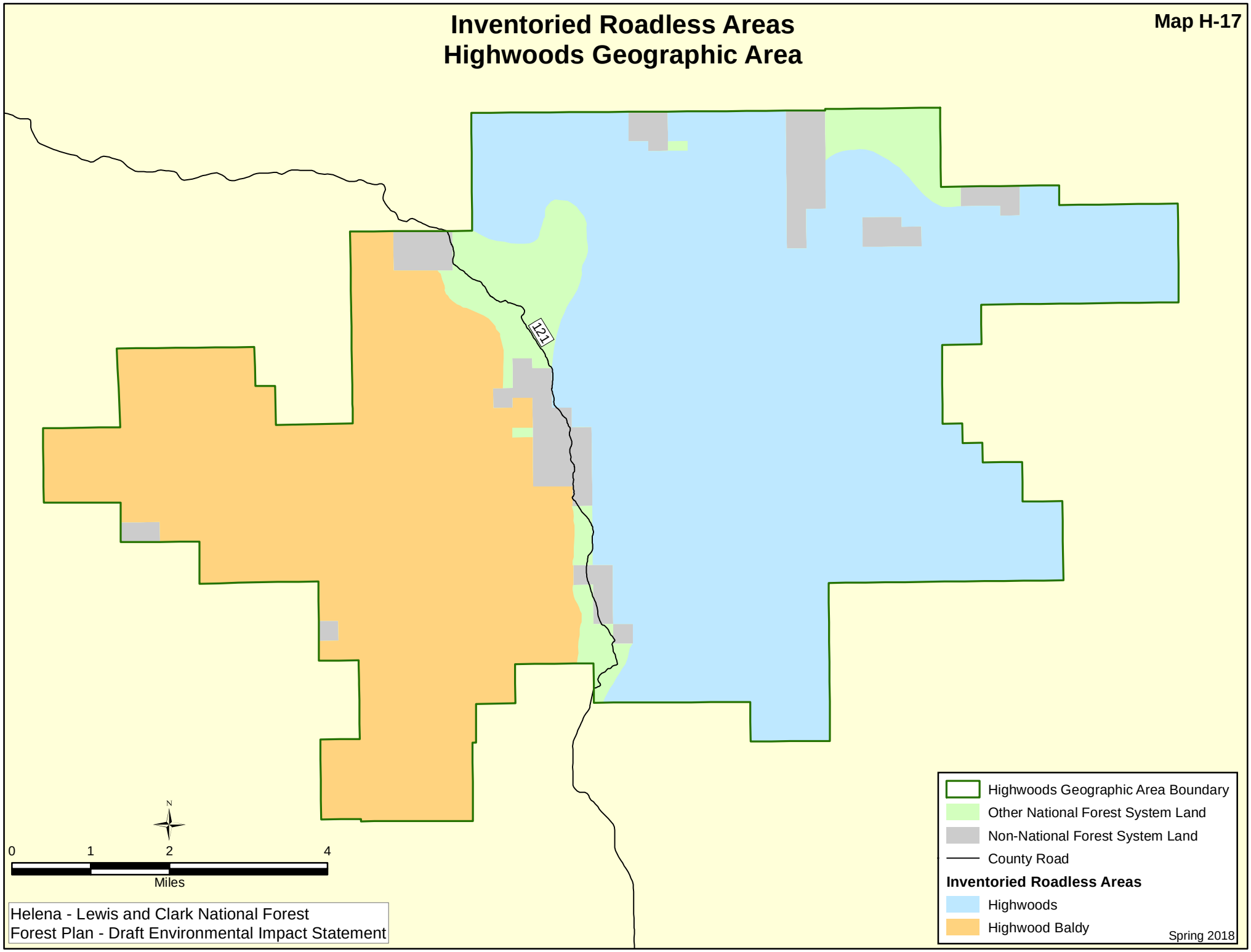
Map H-16



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Inventoried Roadless Areas
Highwoods Geographic Area

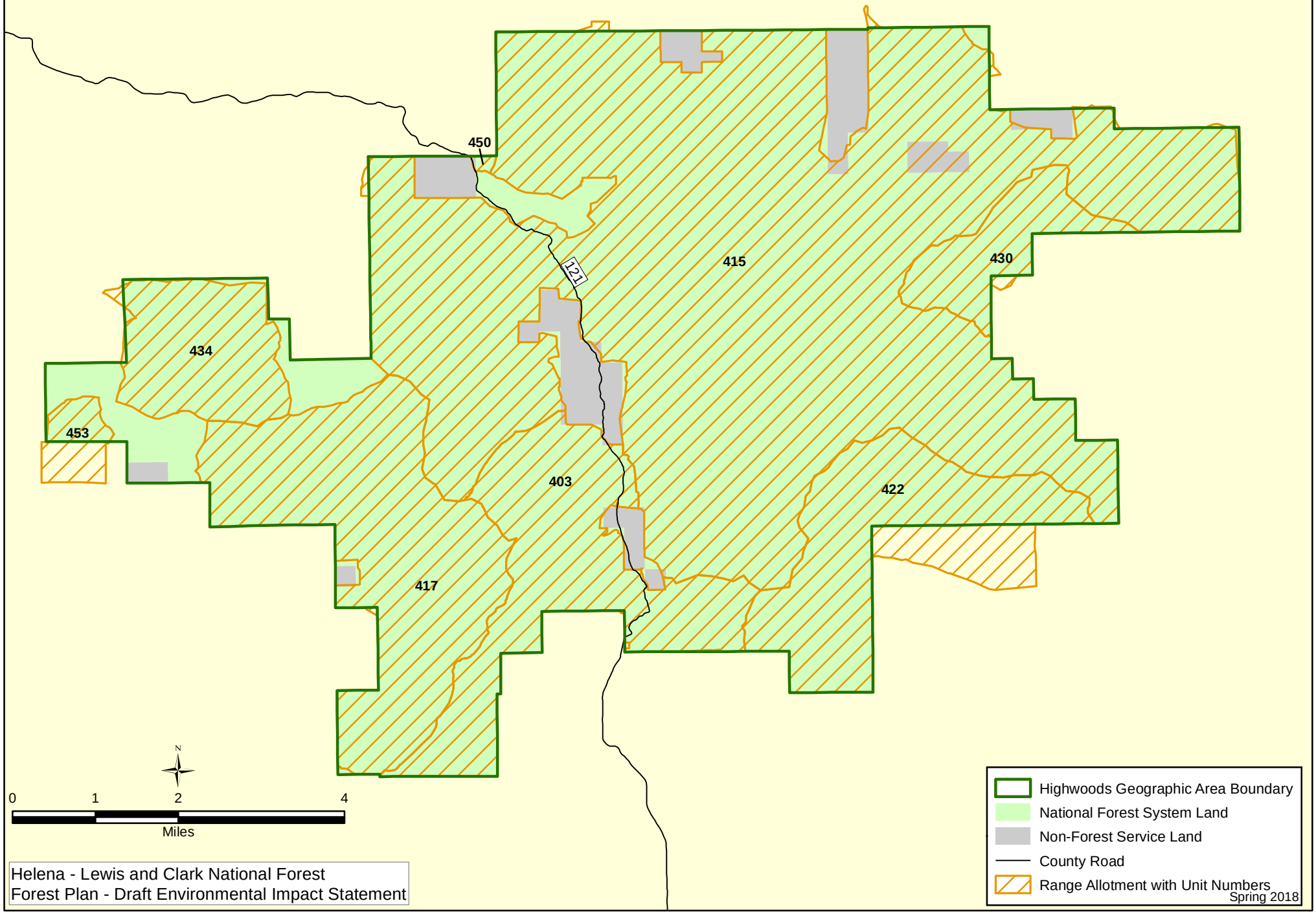
Map H-17



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Range Allotments
Highwoods Geographic Area

Map H-18

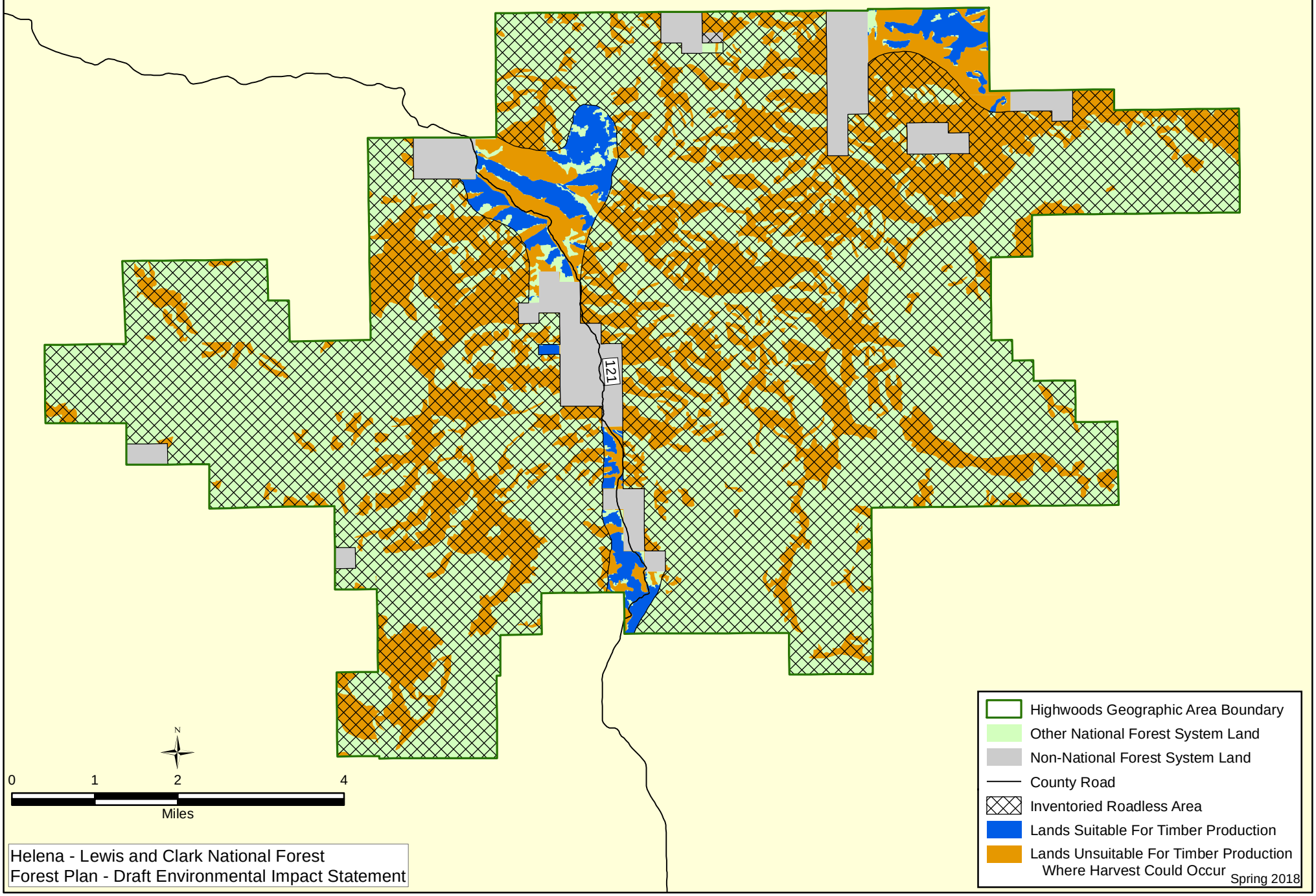


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Lands Where Harvest Could Occur - Alternative A
Highwoods Geographic Area

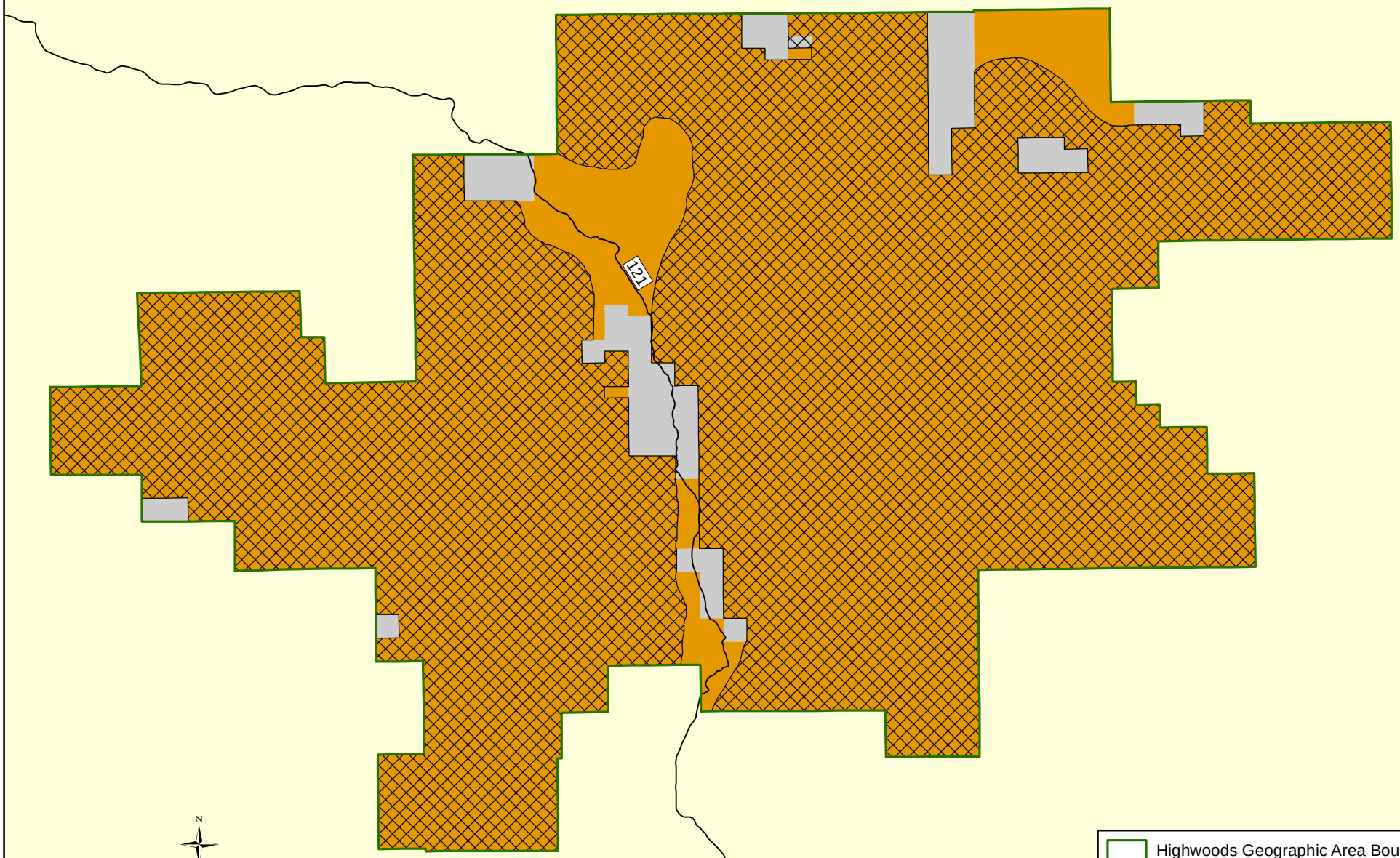
Map H-19



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Lands Where Harvest Could Occur - Alternatives B and C
Highwoods Geographic Area

Map H-20



N

0 1 2 4

Miles

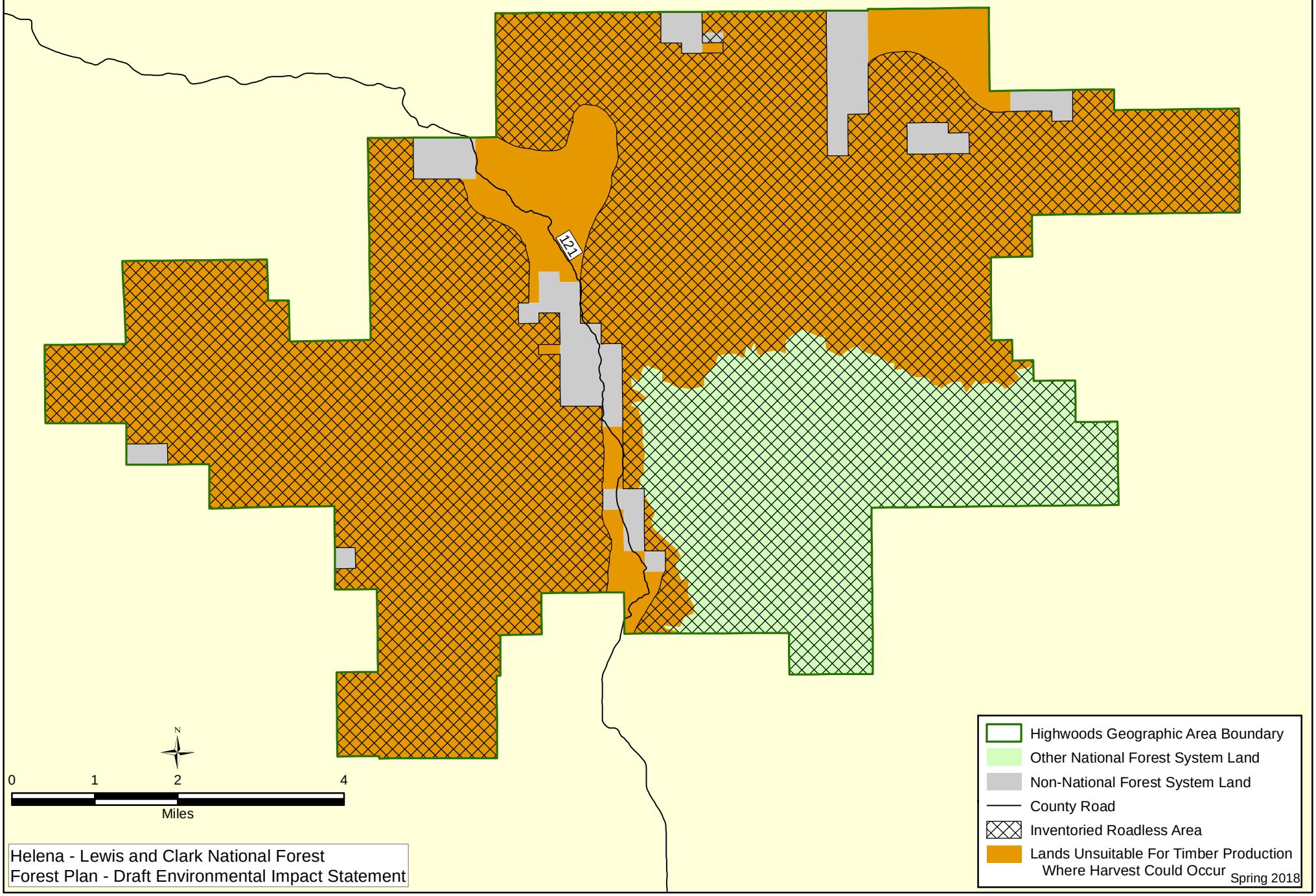
Highwoods Geographic Area Boundary
Non-National Forest System Land
County Road
Inventoried Roadless Area
Lands Unsuitable For Timber Production Where Harvest Could Occur

Spring 2018

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Lands Where Harvest Could Occur - Alternative D
Highwoods Geographic Area

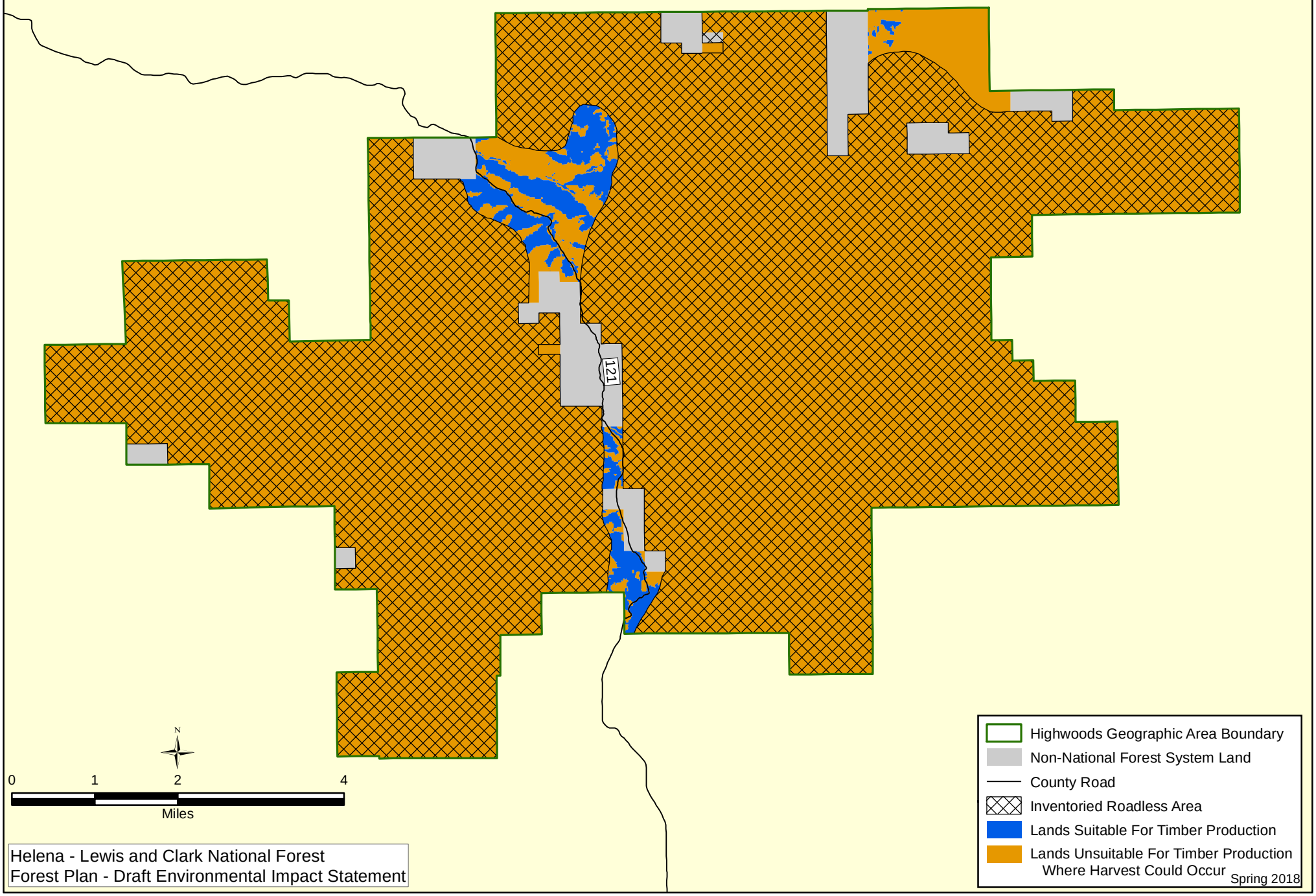
Map H-21



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Lands Where Harvest Could Occur - Alternative E
Highwoods Geographic Area

Map H-22

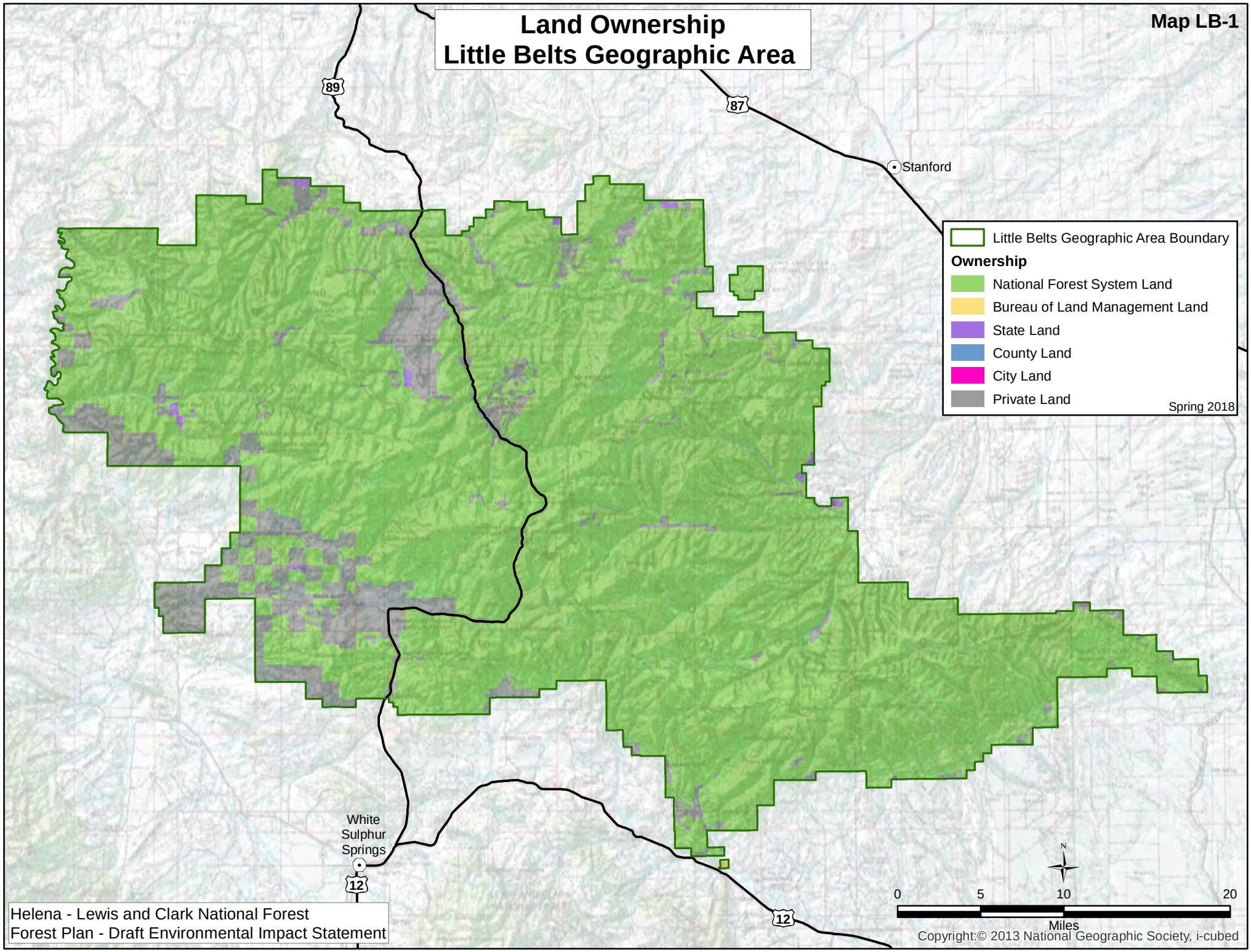


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Spring 2018

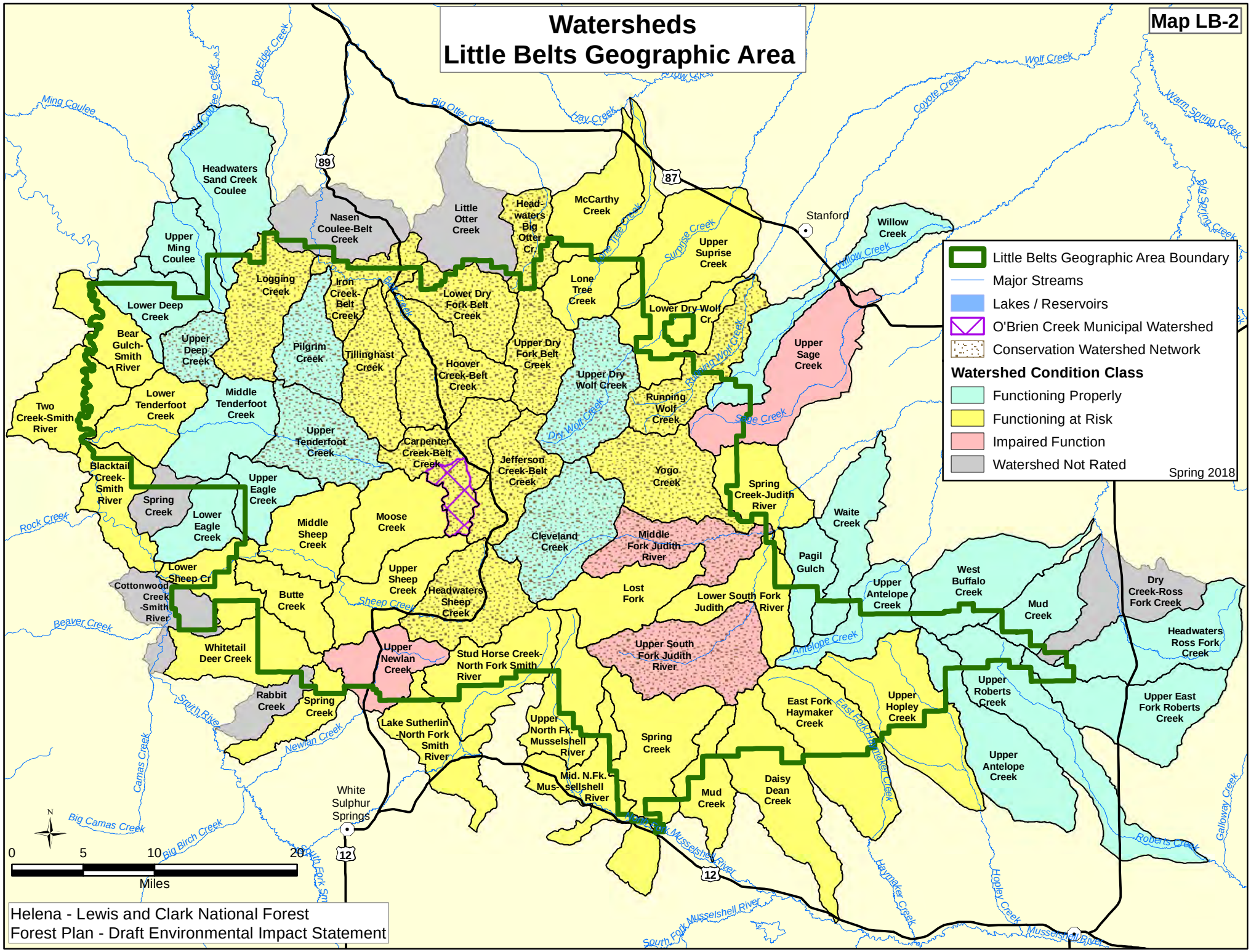
Land Ownership
Little Belts Geographic Area

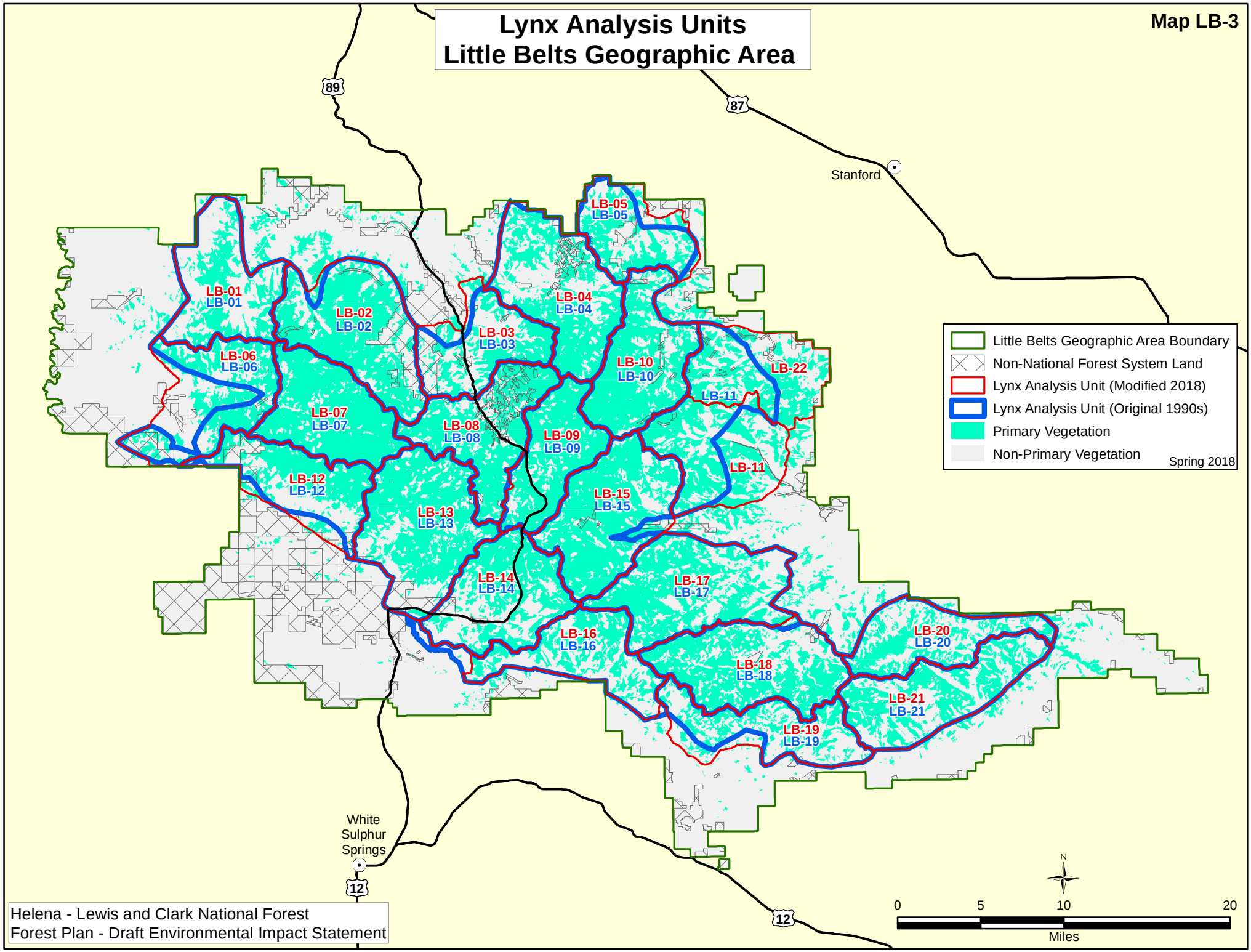
Map LB-1



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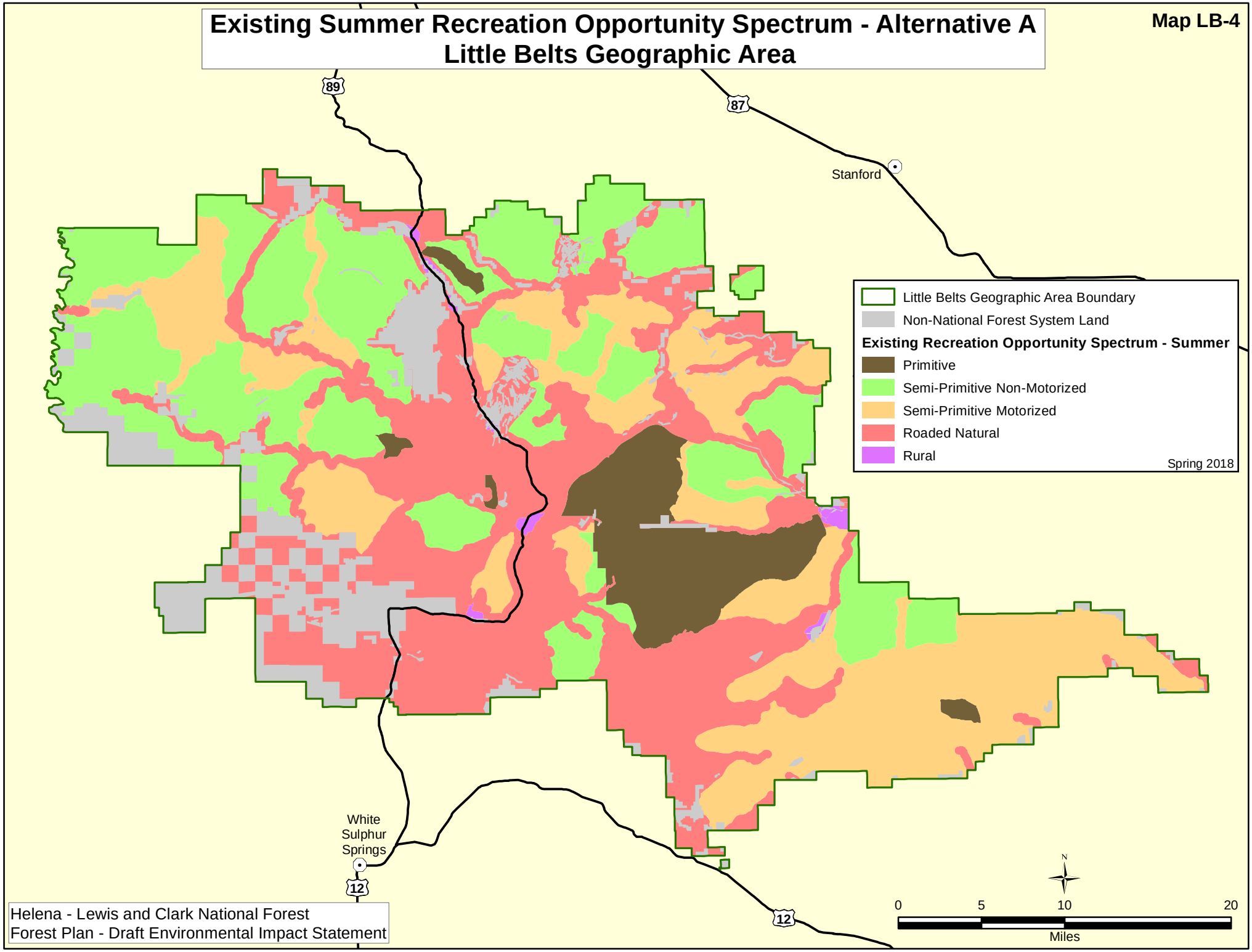
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Watersheds
Little Belts Geographic Area
Map LB-2
Little Belts Geographic Area Boundary
Major Streams
Lakes / Reservoirs
O'Brien Creek Municipal Watershed
Conservation Watershed Network
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018
Headwaters Sand Creek Coulee
Upper Ming Coulee
Nasen Coulee-Belt Creek
Little Otter Creek
Head-waters Big Otter Cr.
McCarthy Creek
Upper Suprise Creek
Willow Creek
Stanford
Logging Creek
Iron Creek-Belt Creek
Lower Dry Fork Belt Creek
Lone Tree Creek
Lower Dry Wolf Cr.
Upper Sage Creek
Lower Deep Creek
Bear Gulch-Smith River
Upper Deep Creek
Pilgrim Creek
Tillinghast Creek
Upper Dry Fork Belt Creek
Hoover Creek-Belt Creek
Upper Dry Wolf Creek
Running Wolf Creek
Two Creek-Smith River
Lower Tenderfoot Creek
Middle Tenderfoot Creek
Upper Tenderfoot Creek
Carpenter Creek-Belt Creek
Jefferson Creek-Belt Creek
Yogo Creek
Spring Creek-Judith River
Blacktail Creek-Smith River
Upper Eagle Creek
Spring Creek
Lower Eagle Creek
Middle Sheep Creek
Moose Creek
Cleveland Creek
Middle Fork Judith River
Waite Creek
Pagil Gulch
Lower Sheep Cr
Cottonwood Creek-Smith River
Butte Creek
Upper Sheep Creek
Headwaters Sheep Creek
Lost Fork
Lower South Fork Judith River
Upper Antelope Creek
West Buffalo Creek
Mud Creek
Dry Creek-Ross Fork Creek
Headwaters Ross Fork Creek
Whitetail Deer Creek
Upper Newlan Creek
Stud Horse Creek-North Fork Smith River
Upper South Fork Judith River
Upper Roberts Creek
Upper East Fork Roberts Creek
Rabbit Creek
Spring Creek
Lake Sutherlin-North Fork Smith River
Upper North Fk. Musselshell River
Spring Creek
East Fork Haymaker Creek
Upper Hopley Creek
Upper Antelope Creek
Mid. N.Fk. Mus-sellshell River
Mud Creek
Daisy Dean Creek
White Sulphur Springs
Rock Creek
Beaver Creek
Smith River
Newlan Creek
Camas Creek
Big Camas Creek
Big Birch Creek
Sheep Creek
Antelope Creek
Roberts Creek
Galloway Creek
Hopley Creek
Haymaker Creek
Box Elder Creek
Ming Coulee
Big Otter Creek
Hay Creek
Wolf Creek
Coyote Creek
Warm Spring Creek
Big Spring Creek
Willow Creek
Surprise Creek
Lone Tree Creek
Running Wolf Creek
Sage Creek
Dry Wolf Creek
Middle Fork Musselshell River
South Fork Musselshell River
Musselshell River
89
87
12
0 5 10 20
Miles
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Lynx Analysis Units
Little Belts Geographic Area
Map LB-3
89
87
Stanford
White Sulphur Springs
12
12
LB-01
LB-02
LB-03
LB-04
LB-05
LB-06
LB-07
LB-08
LB-09
LB-10
LB-11
LB-12
LB-13
LB-14
LB-15
LB-16
LB-17
LB-18
LB-19
LB-20
LB-21
LB-22
Little Belts Geographic Area Boundary
Non-National Forest System Land
Lynx Analysis Unit (Modified 2018)
Lynx Analysis Unit (Original 1990s)
Primary Vegetation
Non-Primary Vegetation
Spring 2018
N
0
5
10
20
Miles
Helena - Lewis and Clark National Forest
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Existing Summer Recreation Opportunity Spectrum - Alternative A
Little Belts Geographic Area

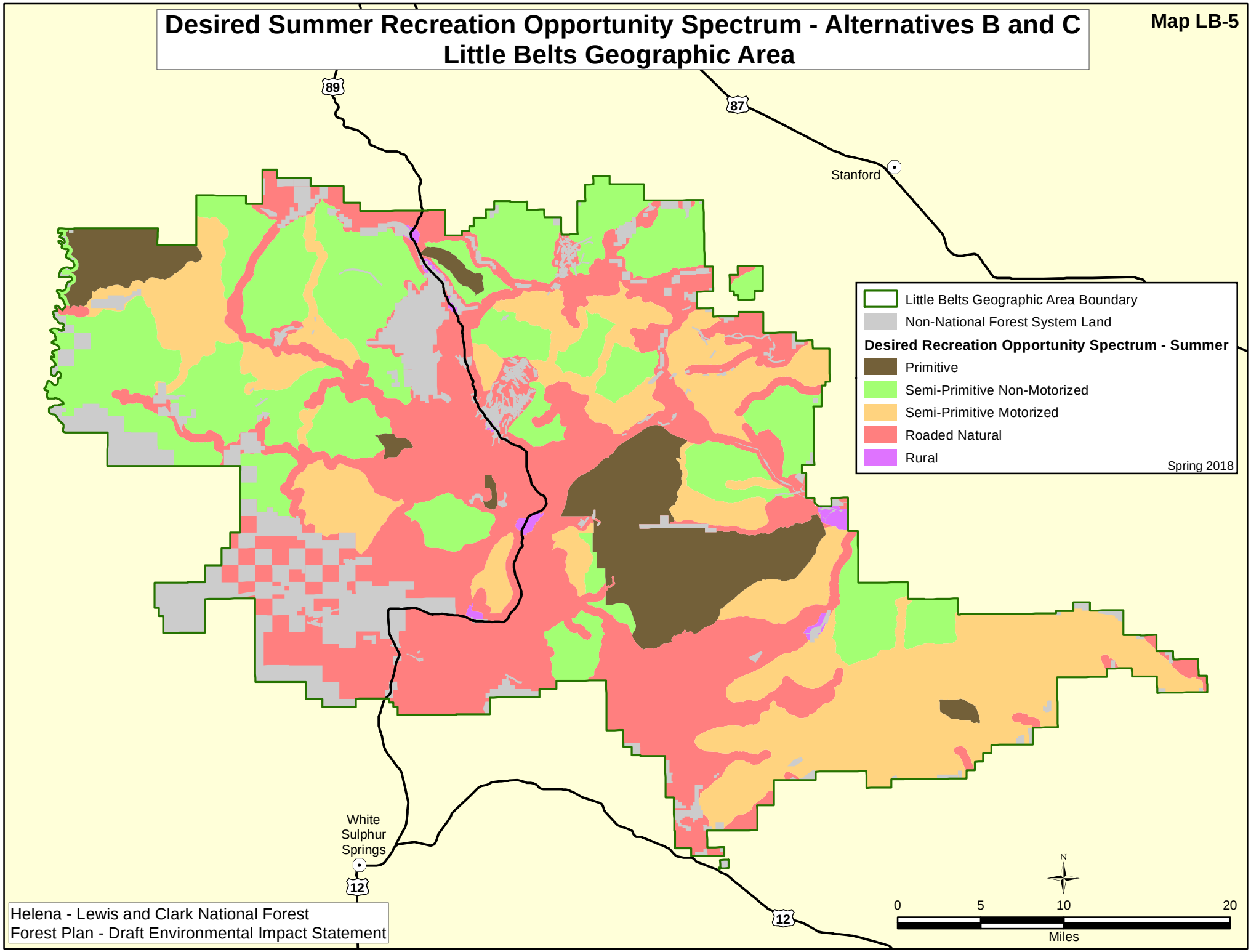
Map LB-4



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Desired Summer Recreation Opportunity Spectrum - Alternatives B and C
Little Belts Geographic Area

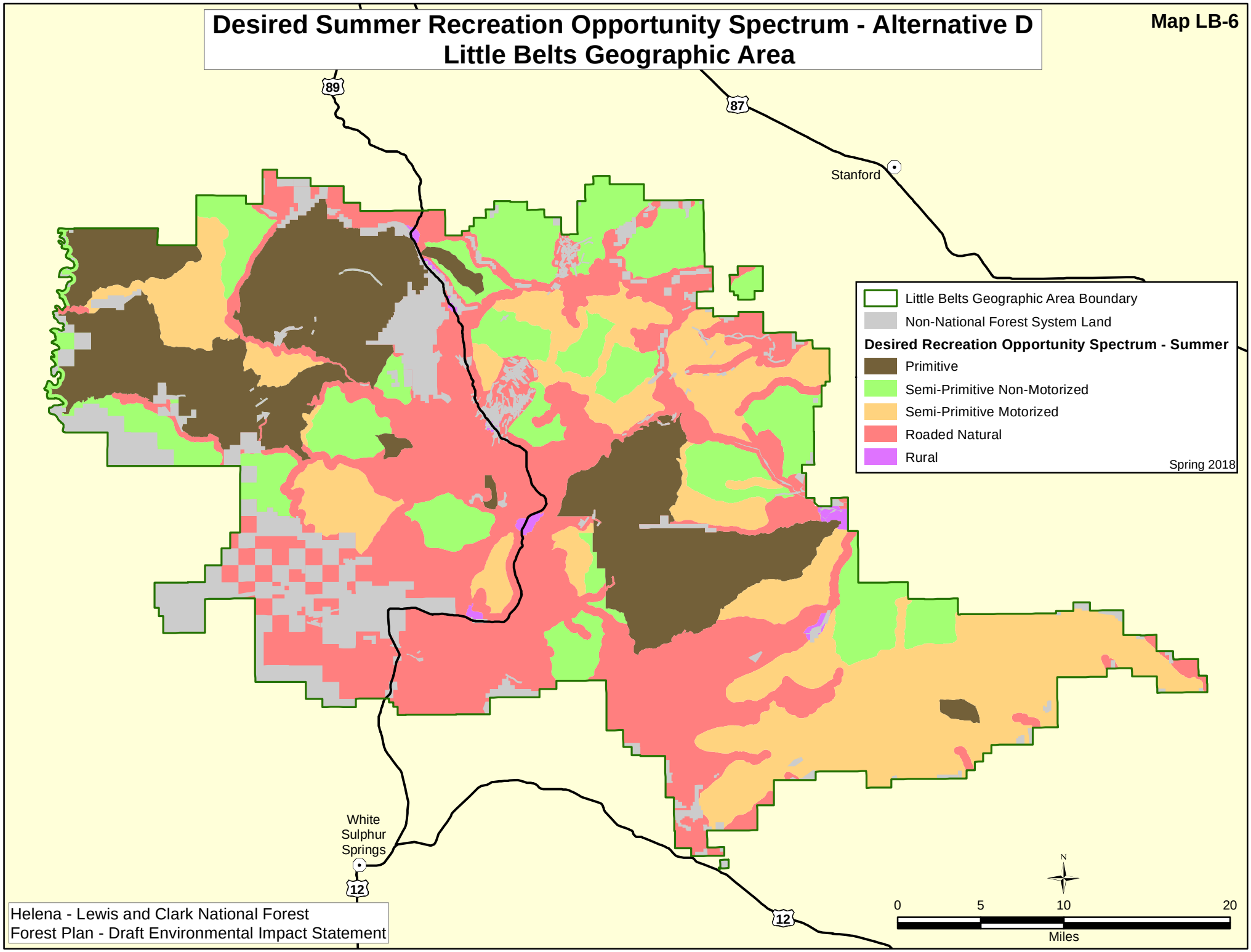
Map LB-5



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Little Belts Geographic Area

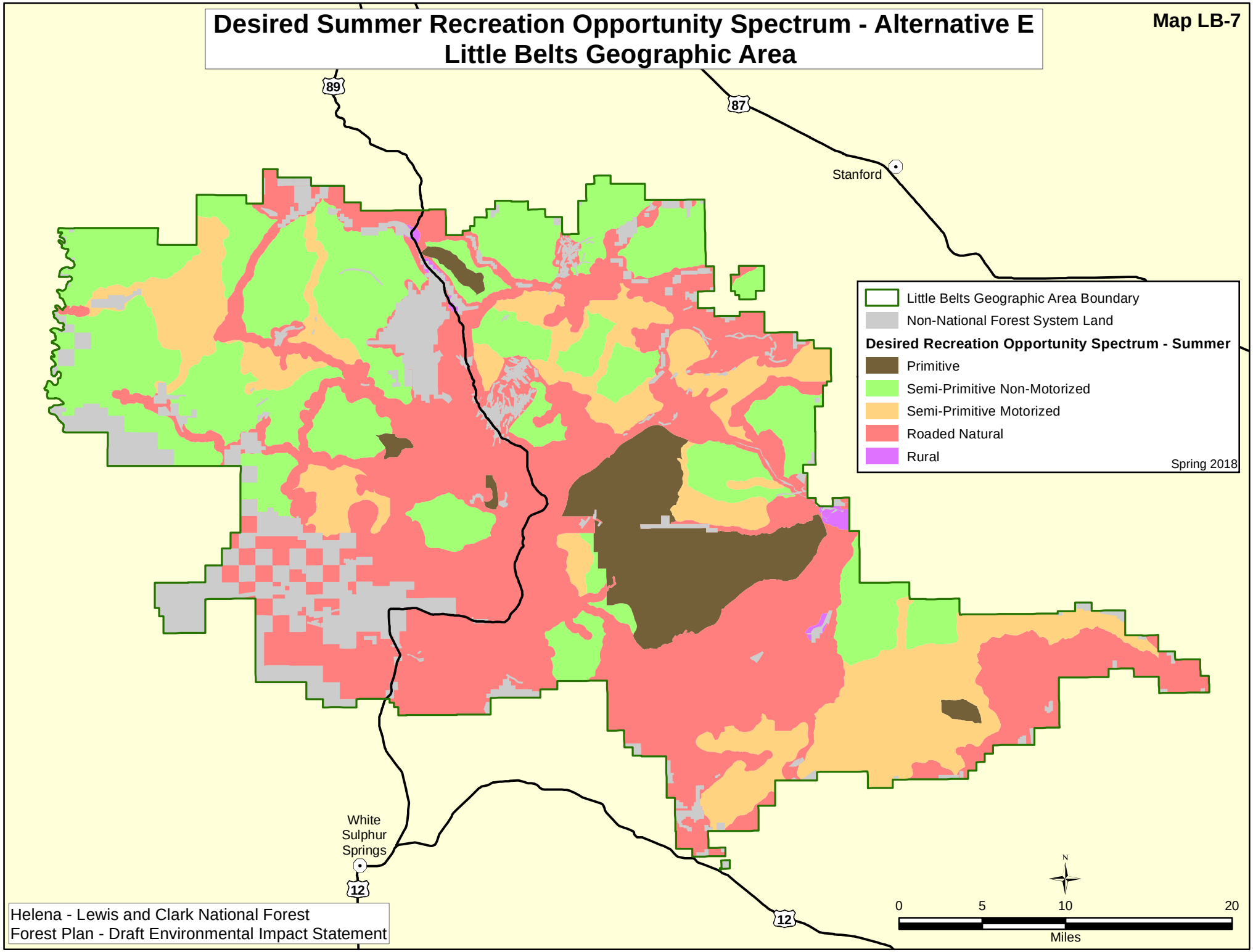
Map LB-6



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Desired Summer Recreation Opportunity Spectrum - Alternative E
Little Belts Geographic Area

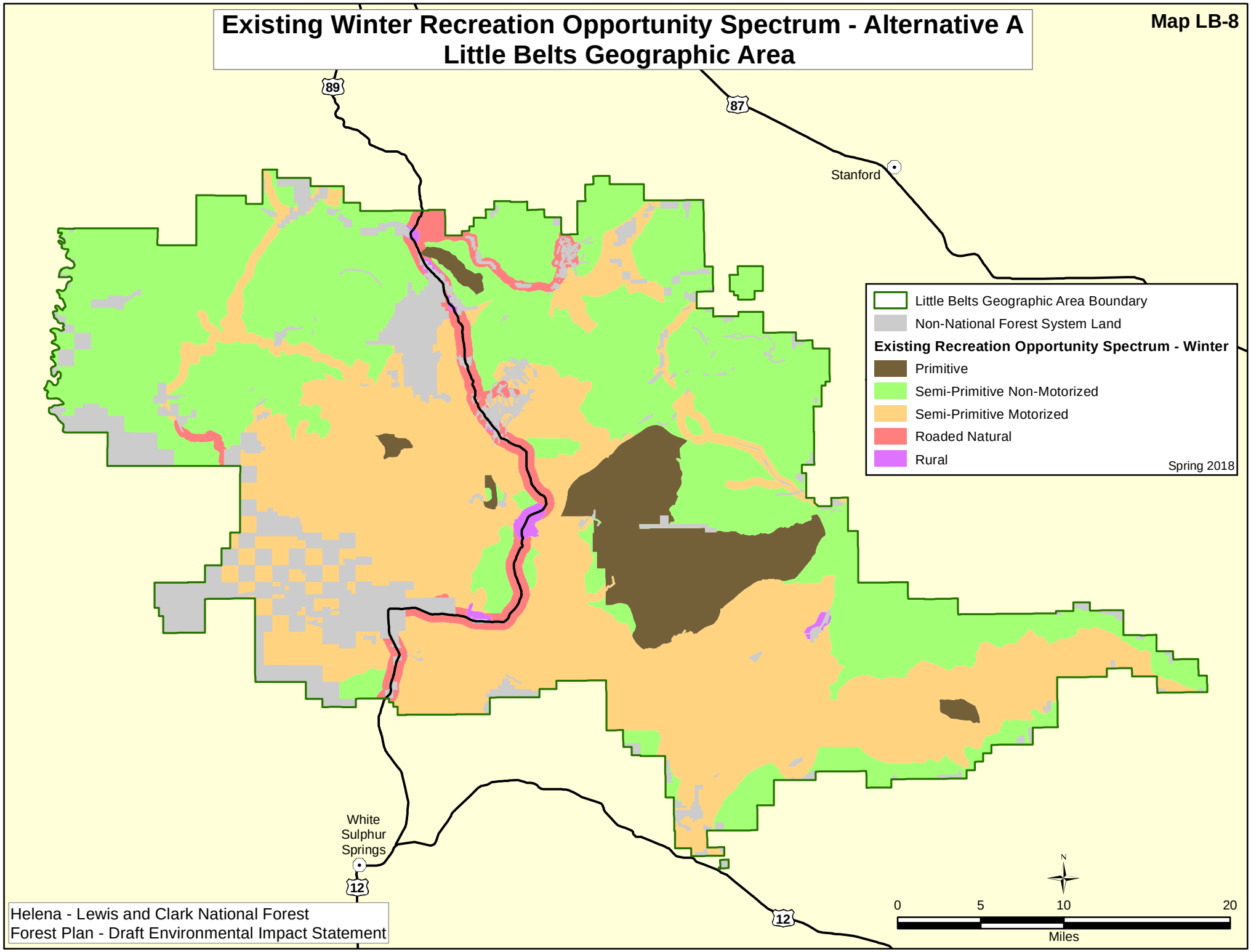
Map LB-7



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Little Belts Geographic Area

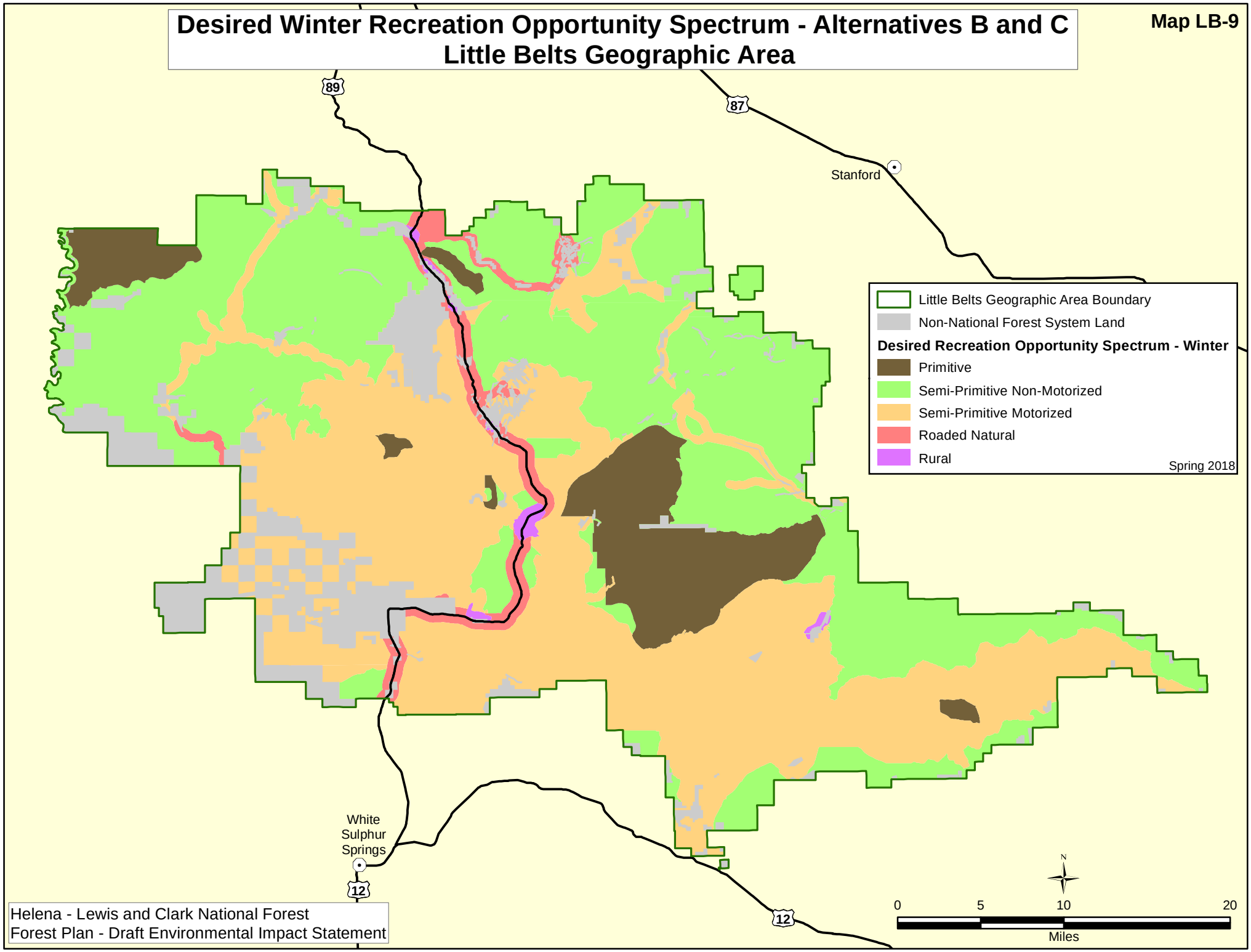
Map LB-8



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Desired Winter Recreation Opportunity Spectrum - Alternatives B and C
Little Belts Geographic Area

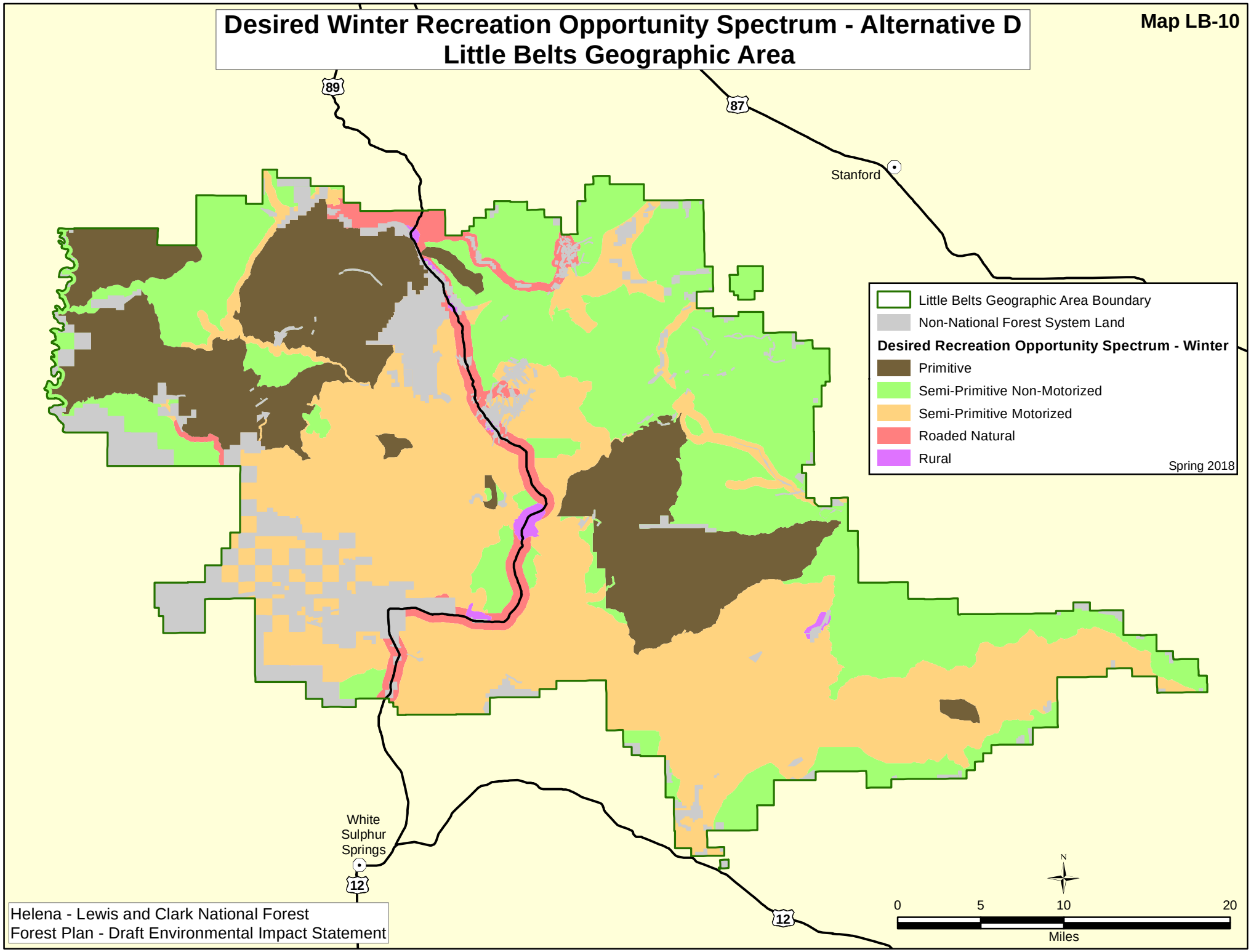
Map LB-9



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Desired Winter Recreation Opportunity Spectrum - Alternative D
Little Belts Geographic Area

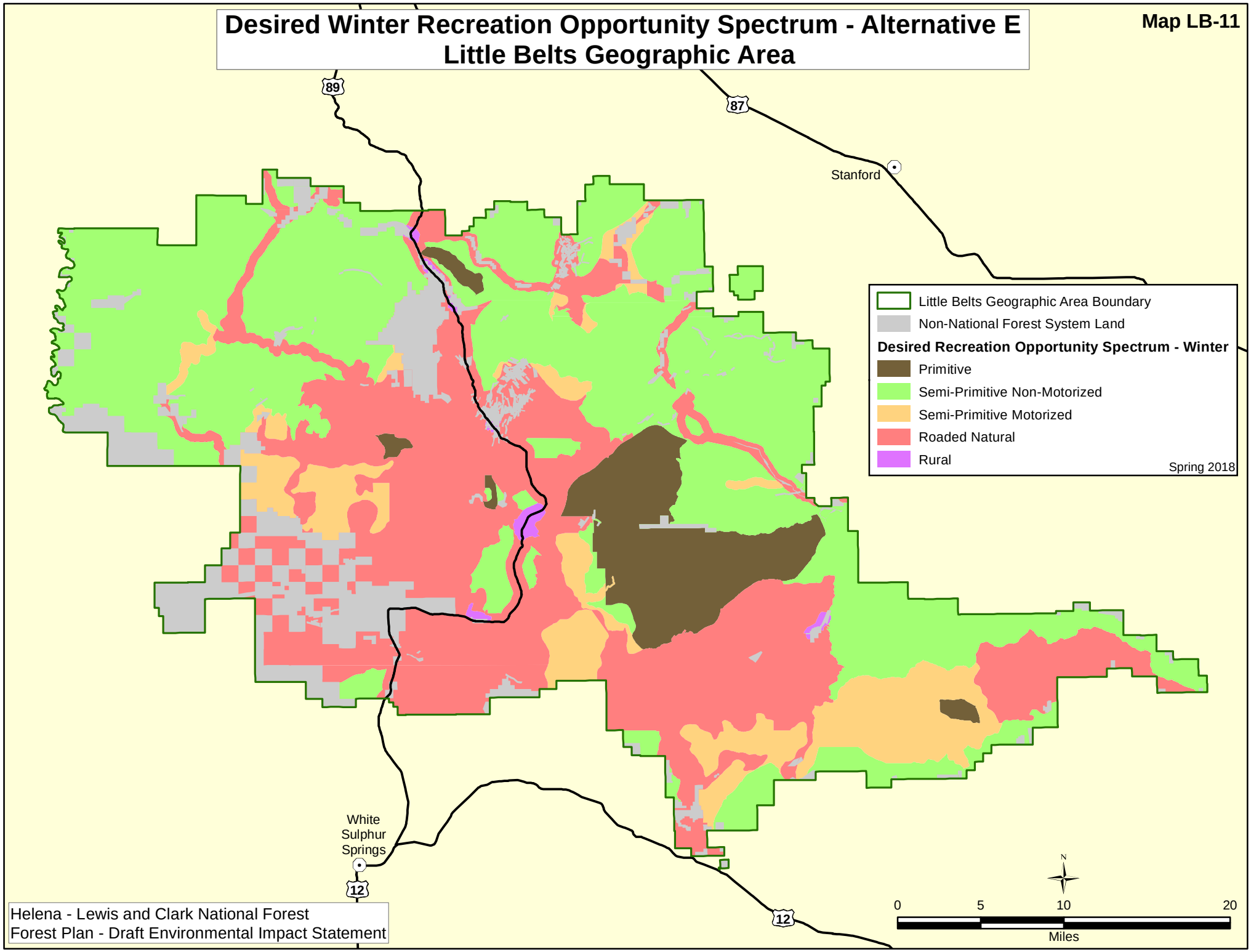
Map LB-10



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Desired Winter Recreation Opportunity Spectrum - Alternative E
Little Belts Geographic Area

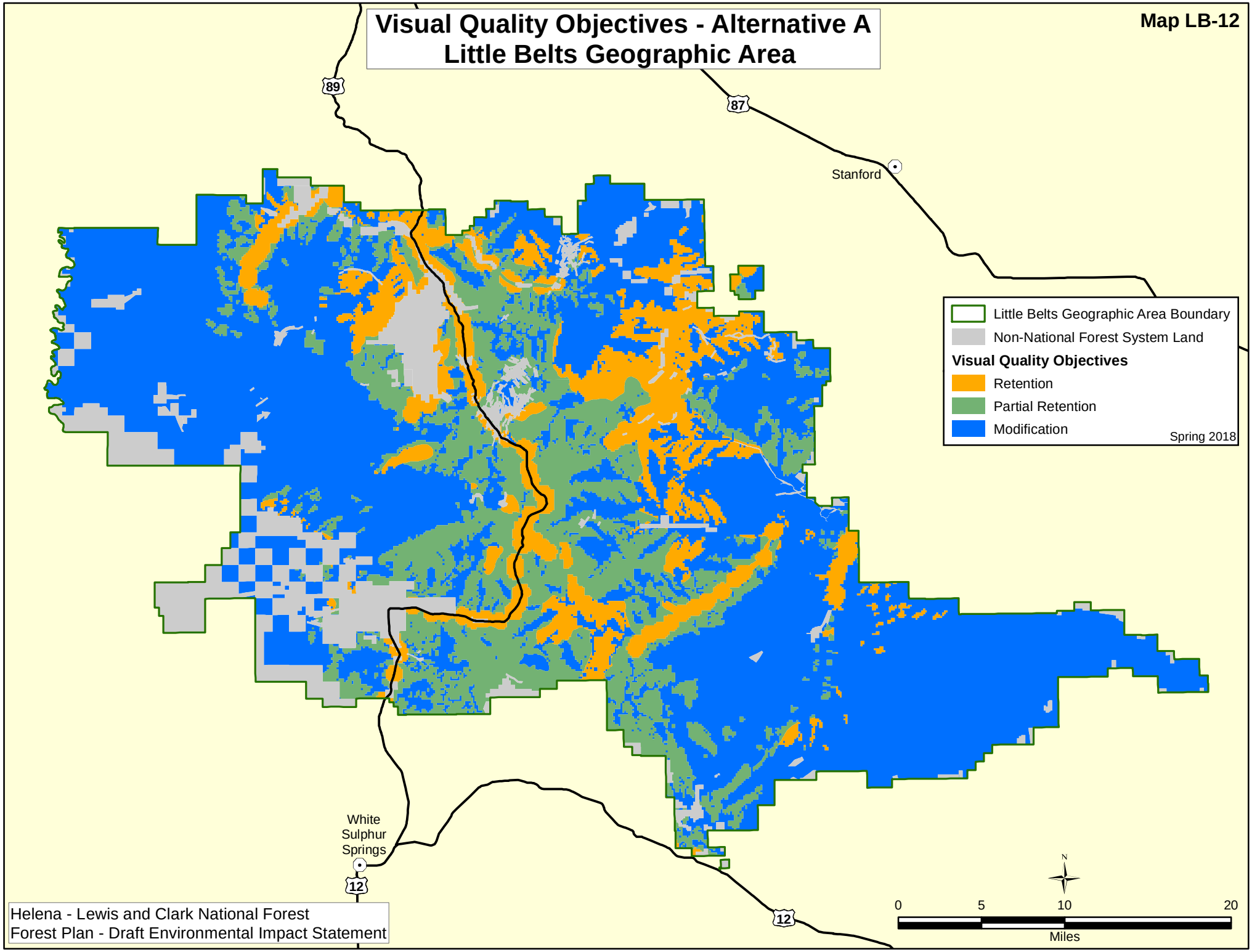
Map LB-11



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Visual Quality Objectives - Alternative A
Little Belts Geographic Area

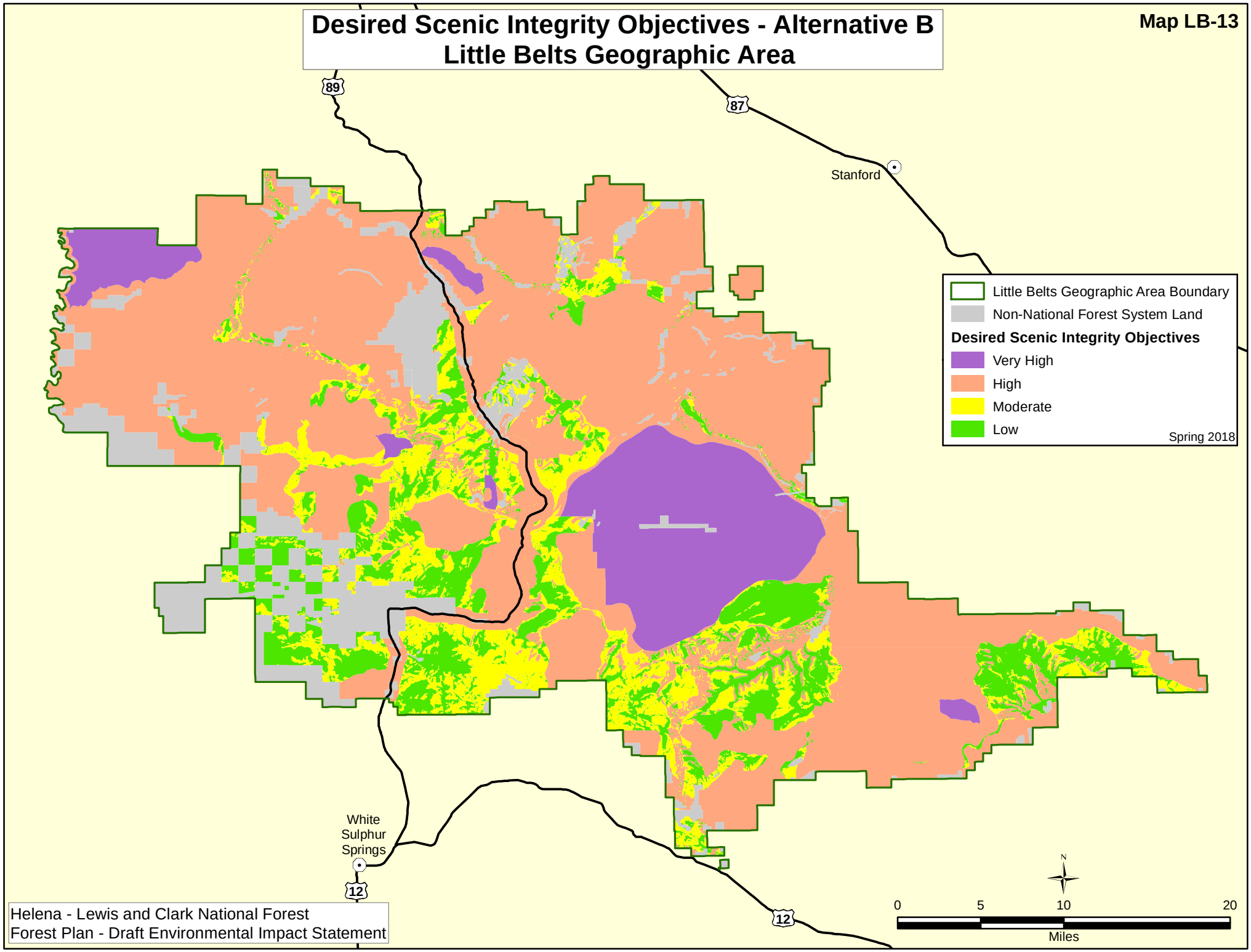
Map LB-12



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Desired Scenic Integrity Objectives - Alternative B
Little Belts Geographic Area

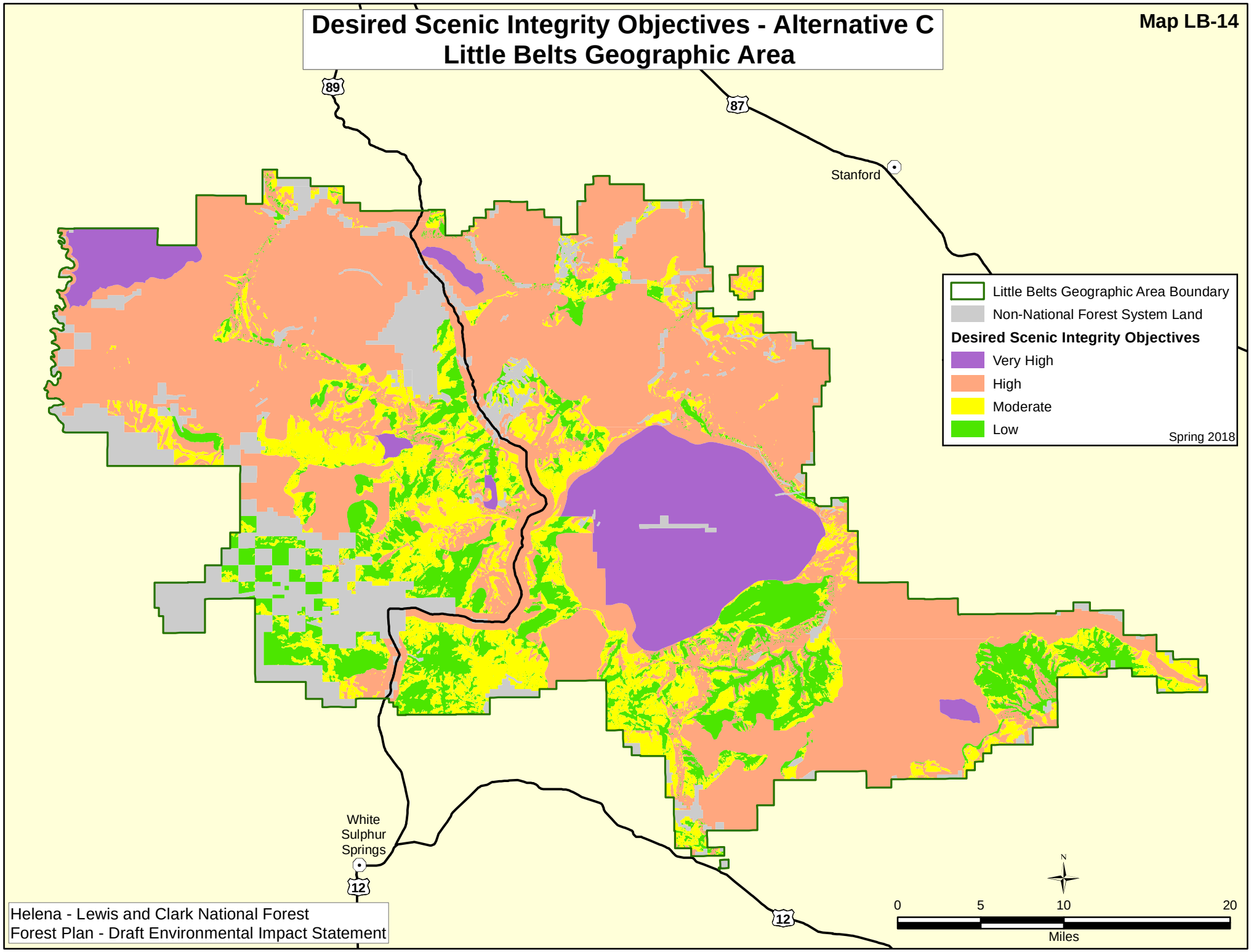
Map LB-13



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Desired Scenic Integrity Objectives - Alternative C
Little Belts Geographic Area

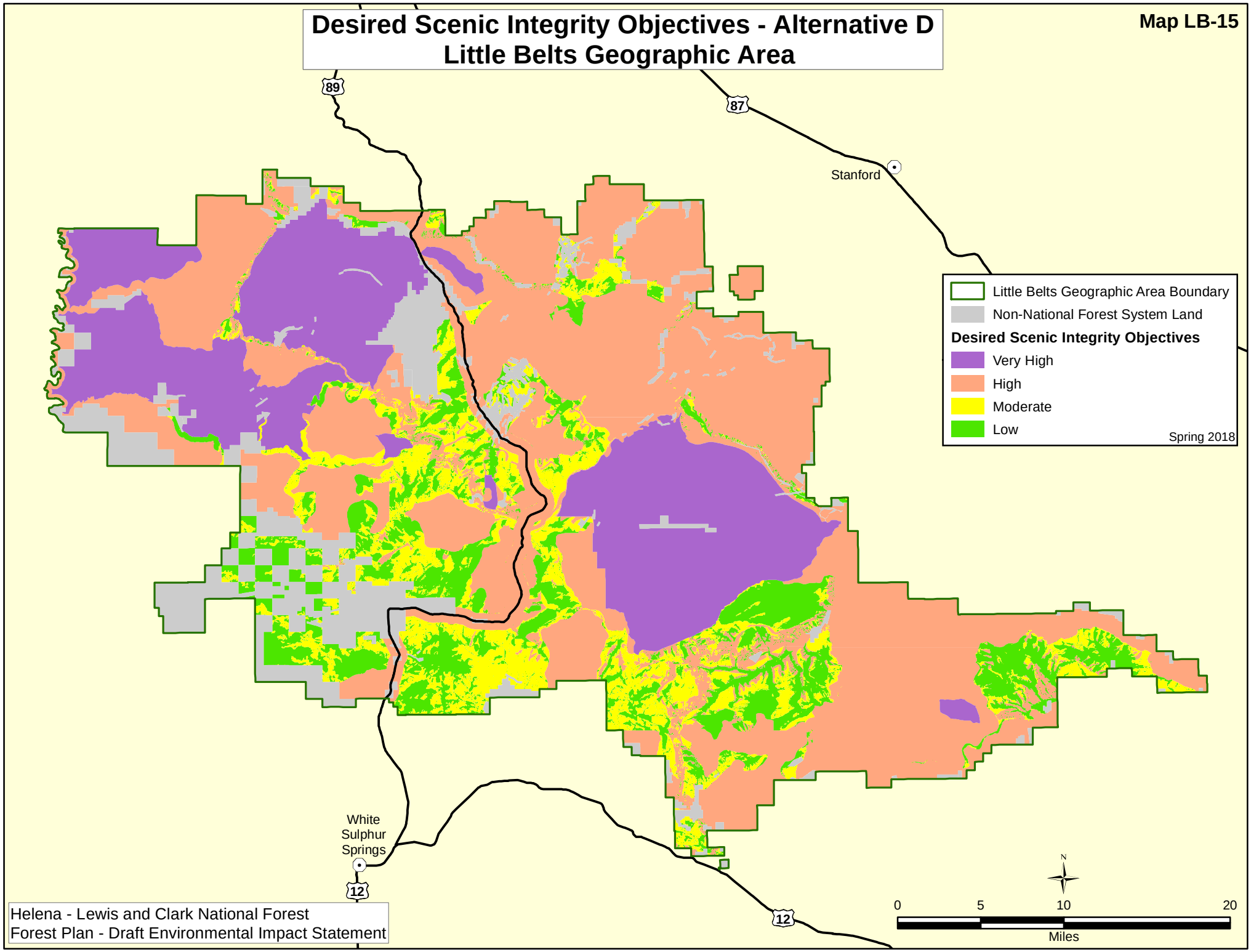
Map LB-14



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Desired Scenic Integrity Objectives - Alternative D
Little Belts Geographic Area

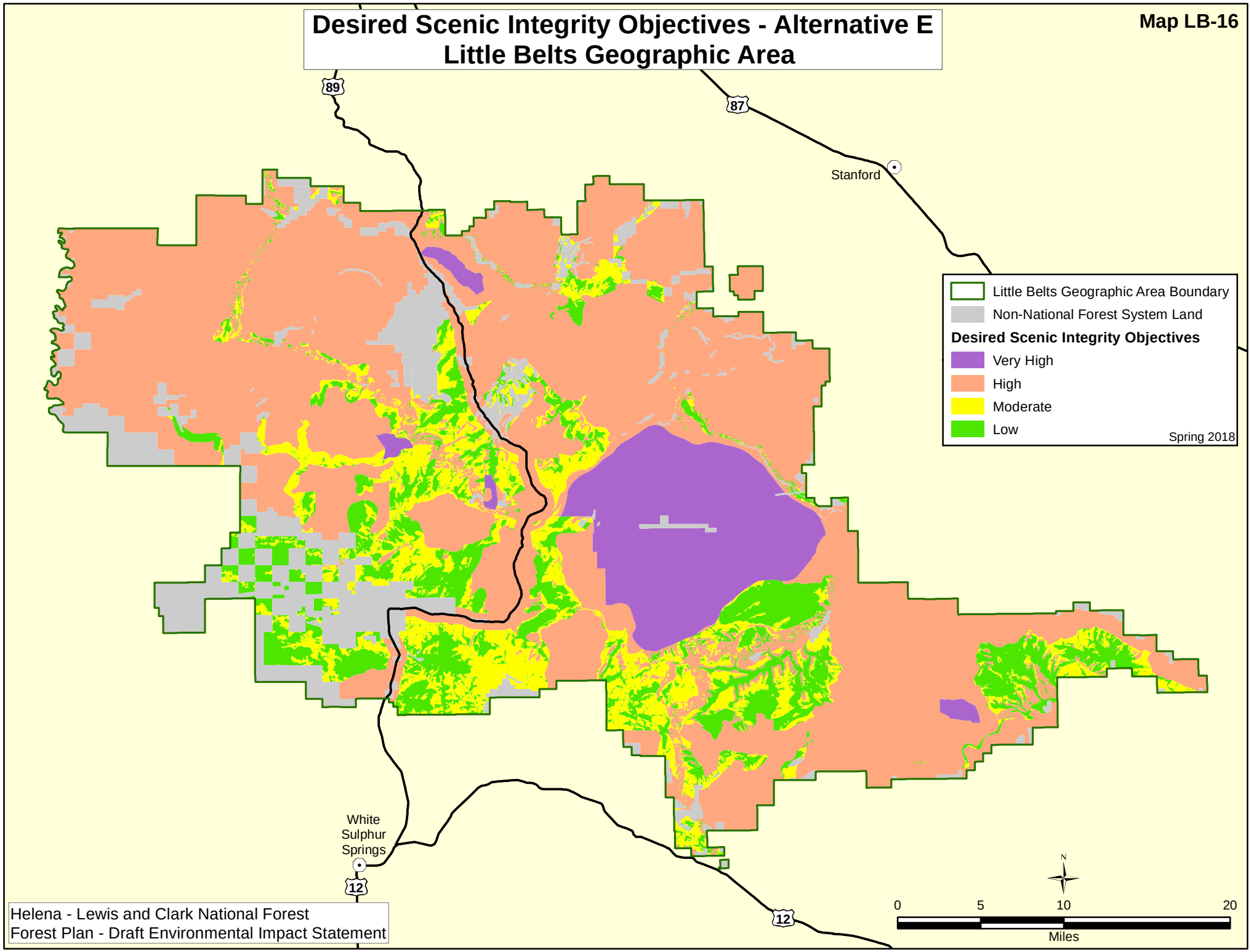
Map LB-15



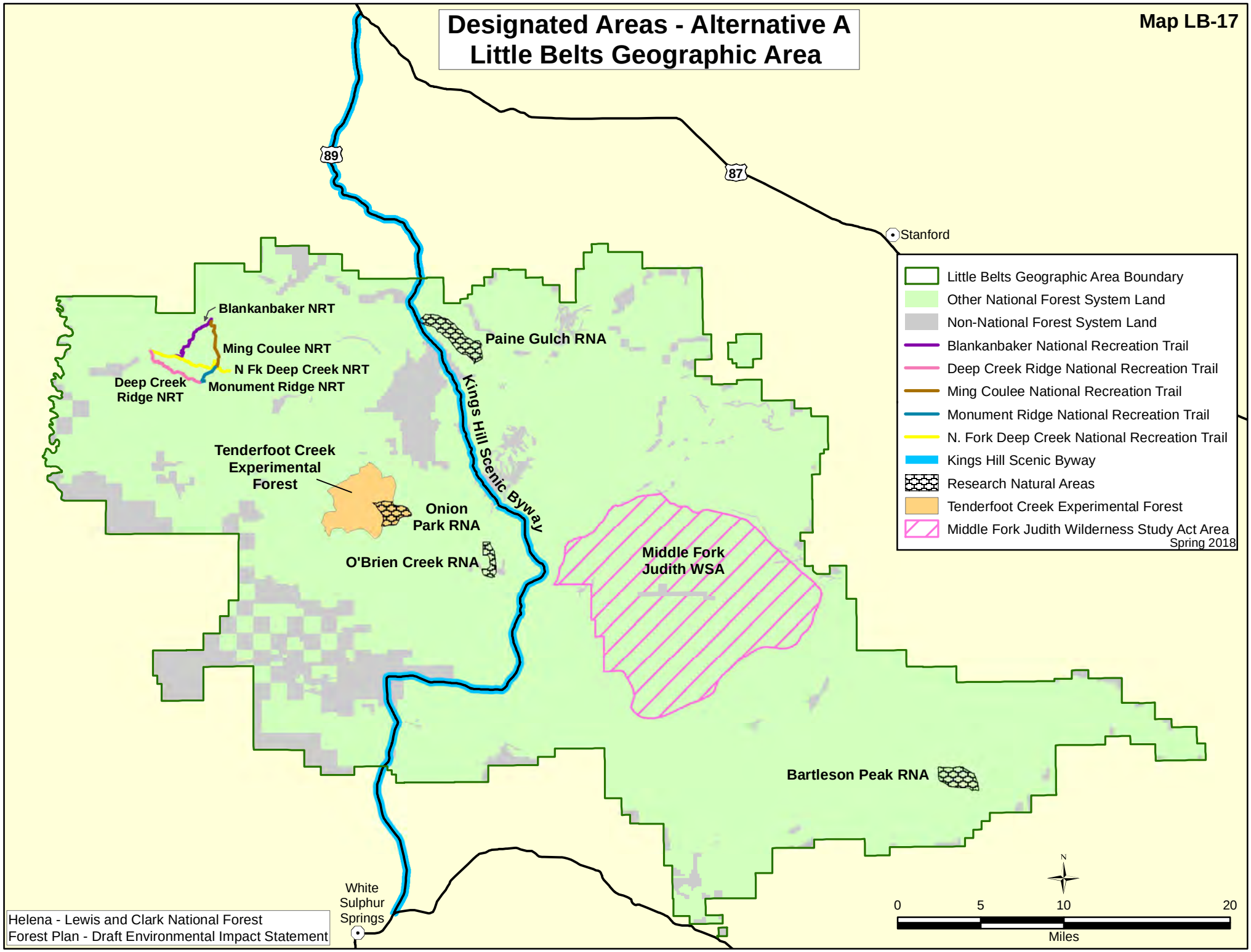
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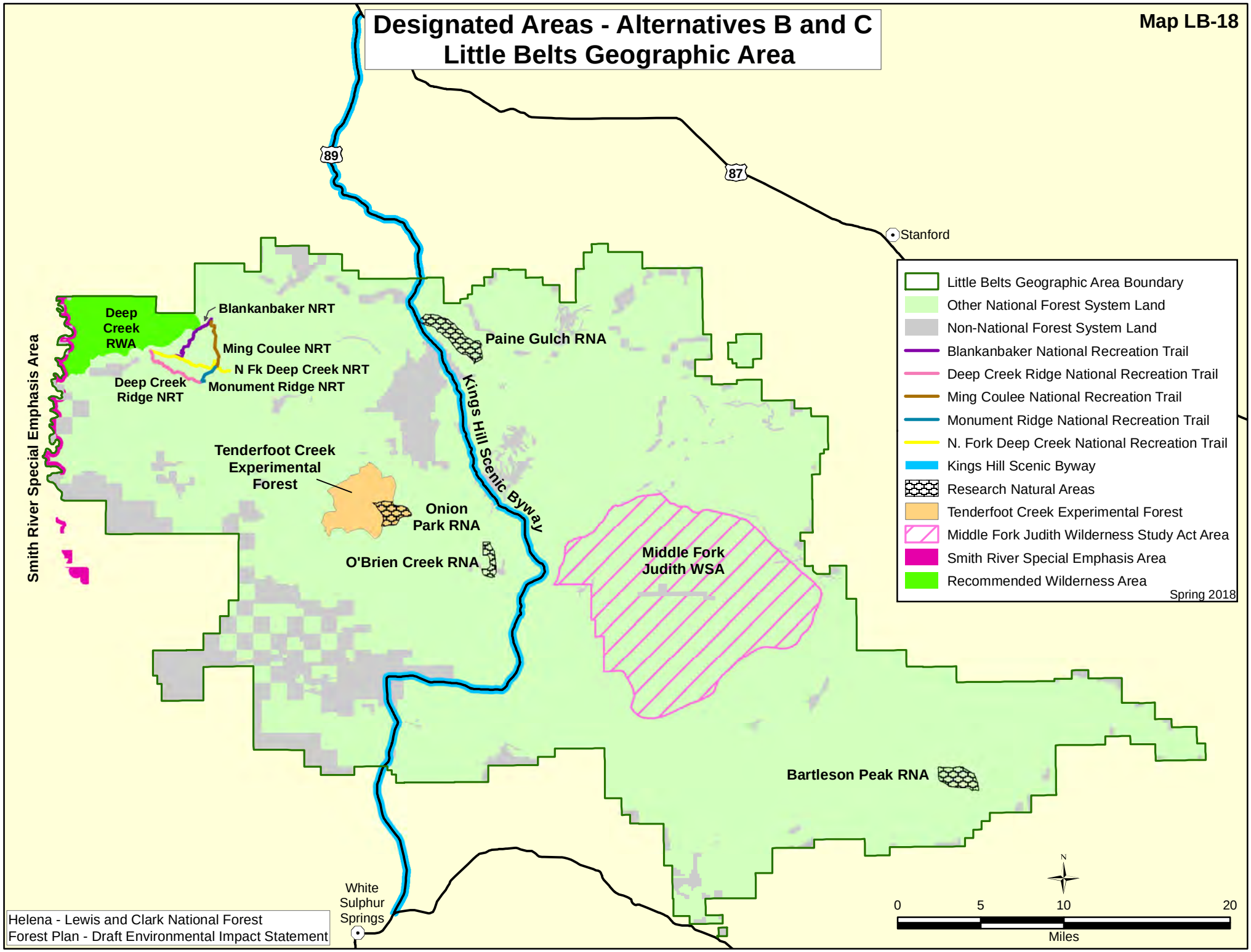
Desired Scenic Integrity Objectives - Alternative E
Little Belts Geographic Area

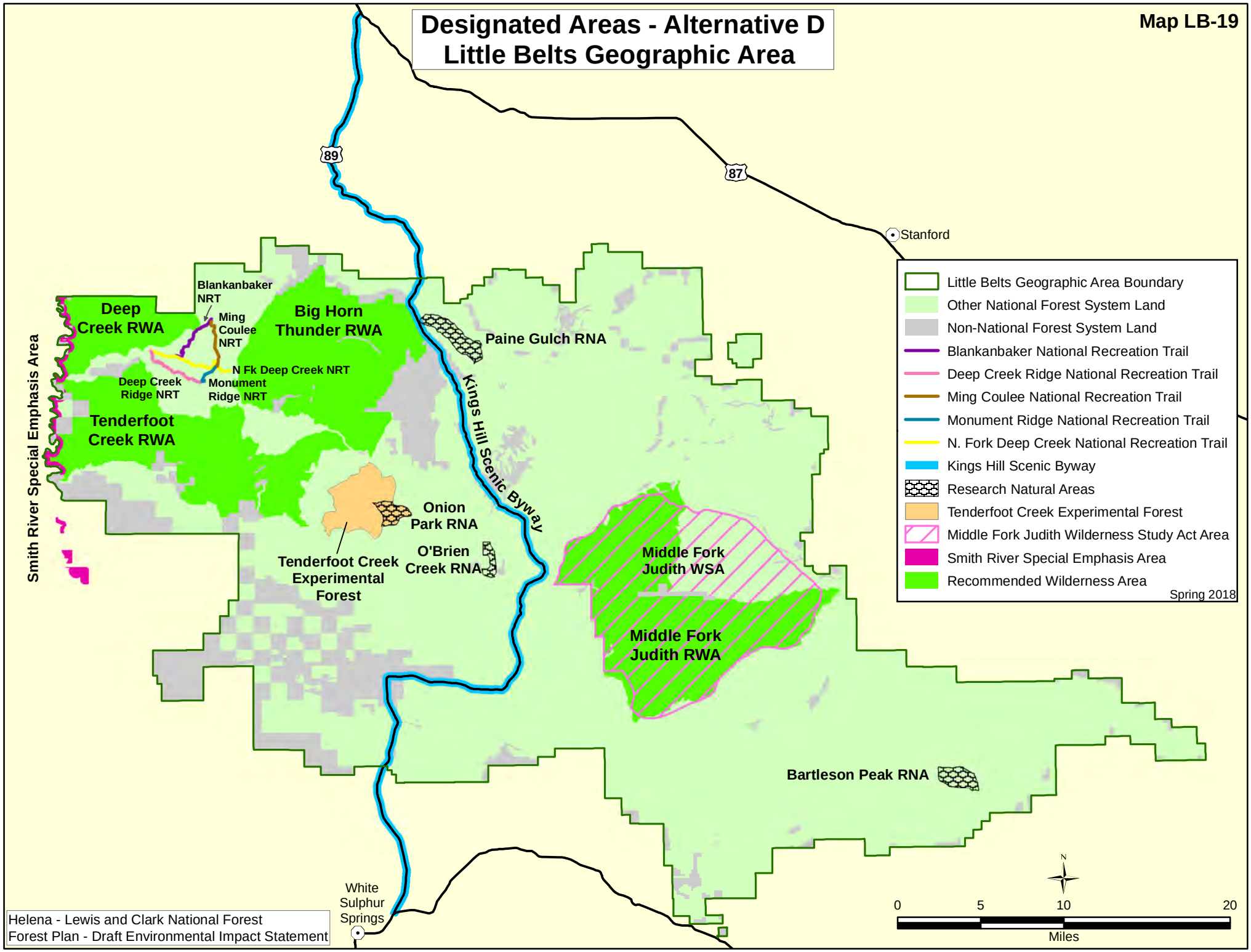
Map LB-16

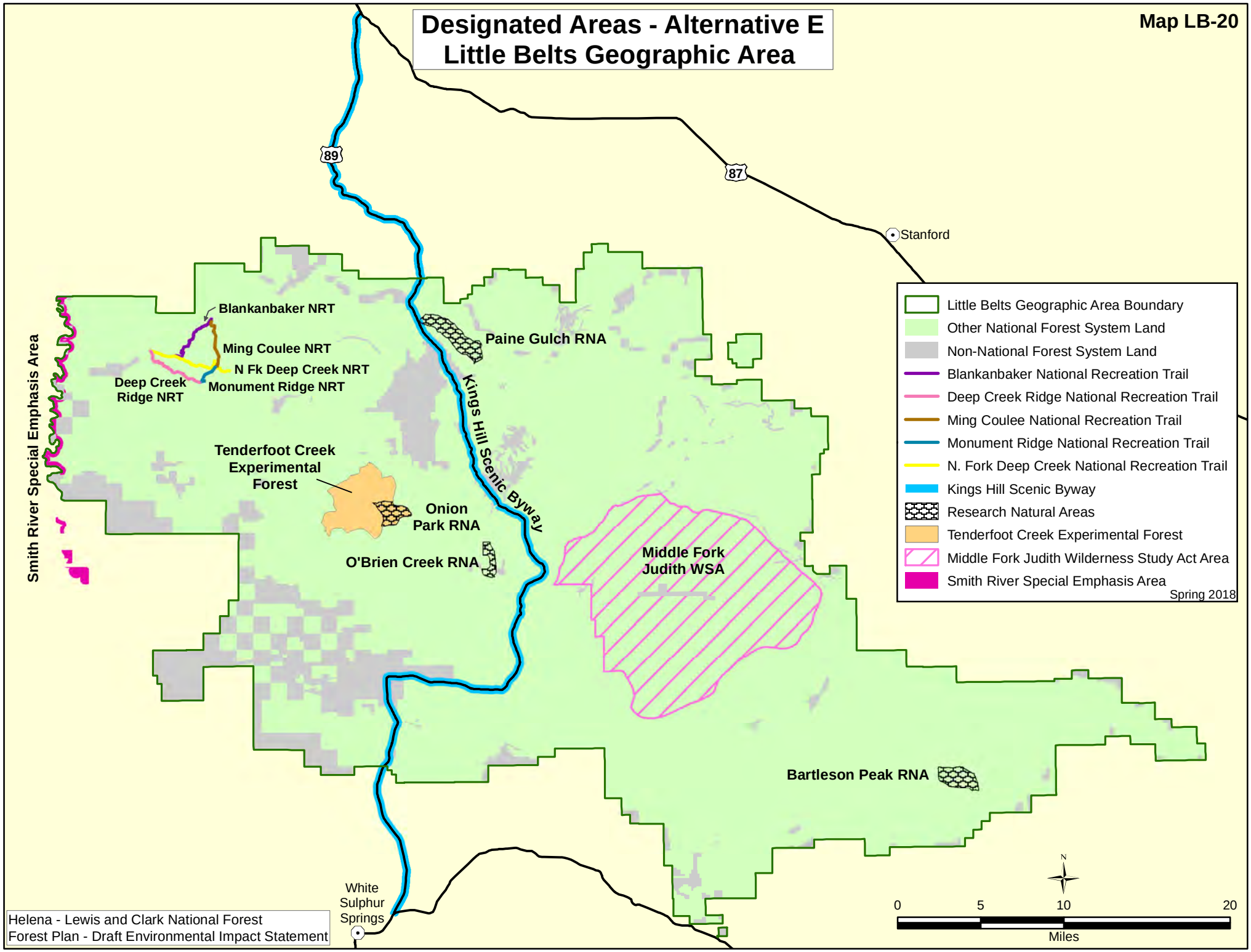


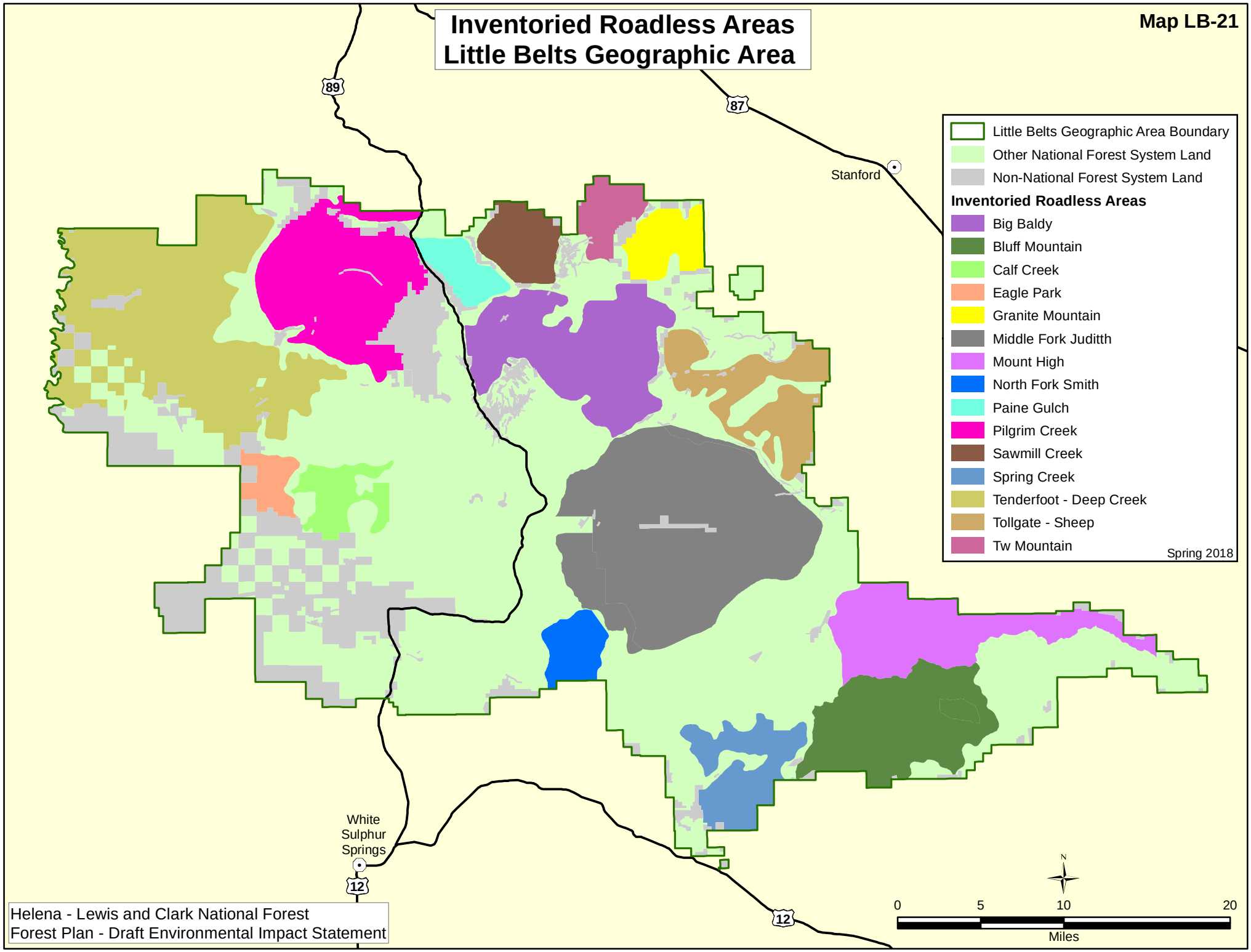
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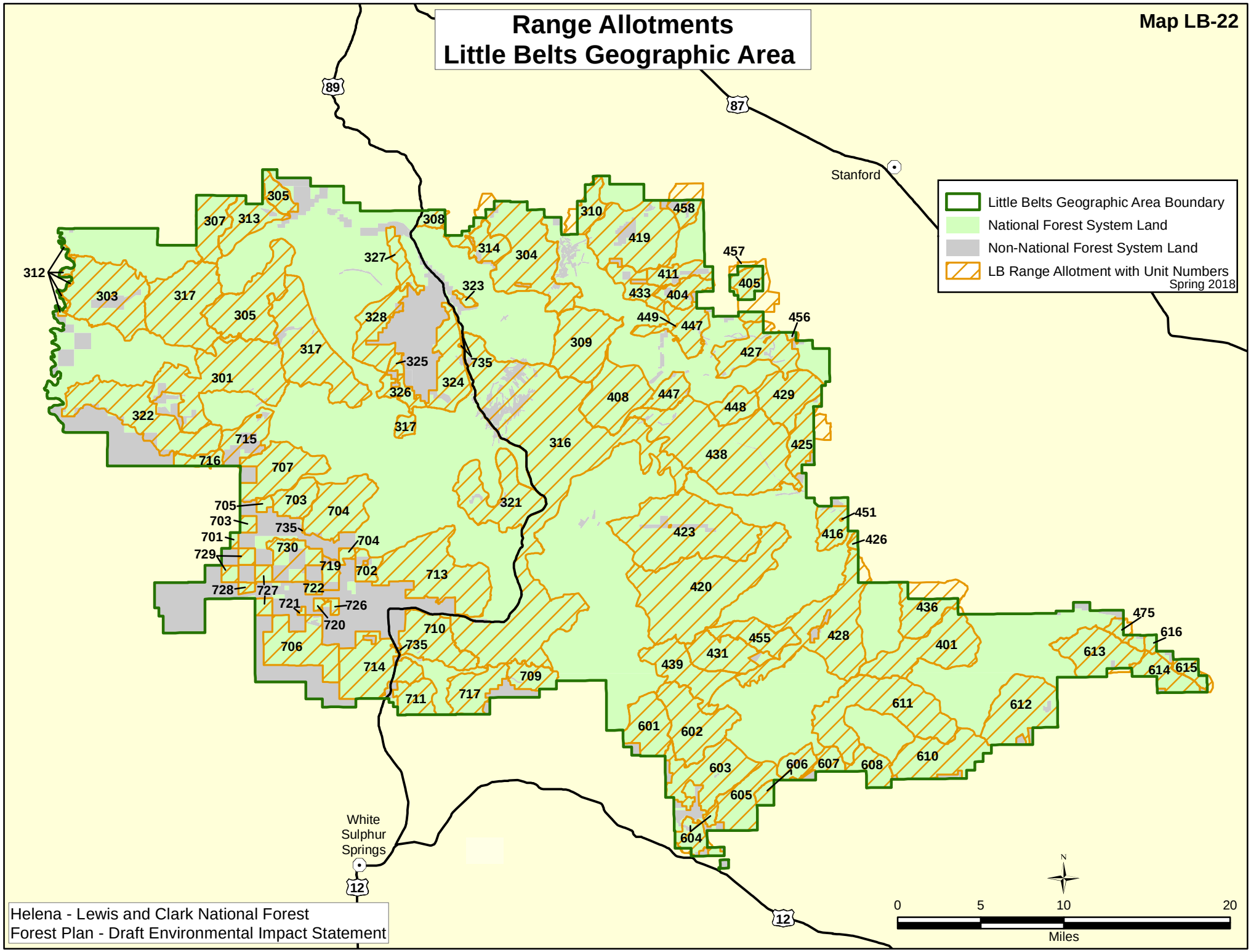

Designated Areas - Alternative A
Little Belts Geographic Area
Map LB-17
89
87
Stanford
Blankanbaker NRT
Ming Coulee NRT
N Fk Deep Creek NRT
Deep Creek Ridge NRT
Monument Ridge NRT
Paine Gulch RNA
Kings Hill Scenic Byway
Tenderfoot Creek Experimental Forest
Onion Park RNA
O'Brien Creek RNA
Middle Fork Judith WSA
Bartleson Peak RNA
White Sulphur Springs
Little Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Blankanbaker National Recreation Trail
Deep Creek Ridge National Recreation Trail
Ming Coulee National Recreation Trail
Monument Ridge National Recreation Trail
N. Fork Deep Creek National Recreation Trail
Kings Hill Scenic Byway
Research Natural Areas
Tenderfoot Creek Experimental Forest
Middle Fork Judith Wilderness Study Act Area
Spring 2018
N
0
5
10
20
Miles
Helena - Lewis and Clark National Forest
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Designated Areas - Alternatives B and C
Little Belts Geographic Area
Map LB-18
89
87
Stanford
Deep Creek RWA
Blankanbaker NRT
Ming Coulee NRT
N Fk Deep Creek NRT
Monument Ridge NRT
Deep Creek Ridge NRT
Smith River Special Emphasis Area
Paine Gulch RNA
Kings Hill Scenic Byway
Tenderfoot Creek Experimental Forest
Onion Park RNA
O'Brien Creek RNA
Middle Fork Judith WSA
Bartleson Peak RNA
White Sulphur Springs
Little Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Blankanbaker National Recreation Trail
Deep Creek Ridge National Recreation Trail
Ming Coulee National Recreation Trail
Monument Ridge National Recreation Trail
N. Fork Deep Creek National Recreation Trail
Kings Hill Scenic Byway
Research Natural Areas
Tenderfoot Creek Experimental Forest
Middle Fork Judith Wilderness Study Act Area
Smith River Special Emphasis Area
Recommended Wilderness Area
Spring 2018
N
0
5
10
20
Miles
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Designated Areas - Alternative D
Little Belts Geographic Area
Map LB-19
89
87
Stanford
Deep Creek RWA
Blankanbaker NRT
Ming Coulee NRT
Big Horn Thunder RWA
Paine Gulch RNA
N Fk Deep Creek NRT
Deep Creek Ridge NRT
Monument Ridge NRT
Tenderfoot Creek RWA
Smith River Special Emphasis Area
Kings Hill Scenic Byway
Onion Park RNA
Tenderfoot Creek Experimental Forest
O'Brien Creek RNA
Middle Fork Judith WSA
Middle Fork Judith RWA
Bartleson Peak RNA
White Sulphur Springs
Little Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Blankanbaker National Recreation Trail
Deep Creek Ridge National Recreation Trail
Ming Coulee National Recreation Trail
Monument Ridge National Recreation Trail
N. Fork Deep Creek National Recreation Trail
Kings Hill Scenic Byway
Research Natural Areas
Tenderfoot Creek Experimental Forest
Middle Fork Judith Wilderness Study Act Area
Smith River Special Emphasis Area
Recommended Wilderness Area
Spring 2018
N
0
5
10
20
Miles
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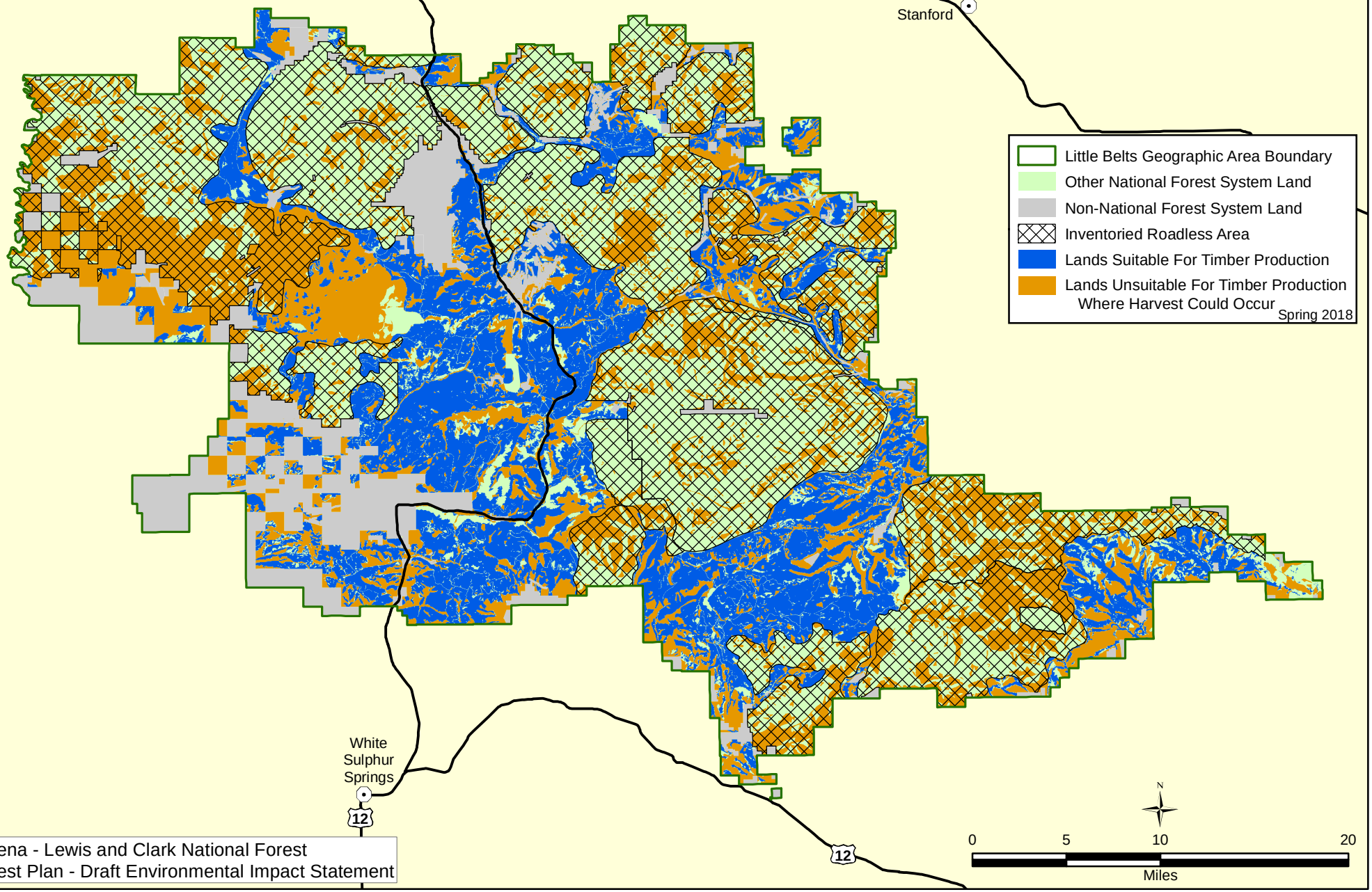

Designated Areas - Alternative E
Little Belts Geographic Area
Map LB-20
89
87
Stanford
Blankanbaker NRT
Ming Coulee NRT
N Fk Deep Creek NRT
Monument Ridge NRT
Deep Creek Ridge NRT
Smith River Special Emphasis Area
Paine Gulch RNA
Kings Hill Scenic Byway
Tenderfoot Creek Experimental Forest
Onion Park RNA
O'Brien Creek RNA
Middle Fork Judith WSA
Bartleson Peak RNA
White Sulphur Springs
Little Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Blankanbaker National Recreation Trail
Deep Creek Ridge National Recreation Trail
Ming Coulee National Recreation Trail
Monument Ridge National Recreation Trail
N. Fork Deep Creek National Recreation Trail
Kings Hill Scenic Byway
Research Natural Areas
Tenderfoot Creek Experimental Forest
Middle Fork Judith Wilderness Study Act Area
Smith River Special Emphasis Area
Spring 2018
N
0
5
10
20
Miles
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Inventoried Roadless Areas
Little Belts Geographic Area
Map LB-21
89
87
Stanford
White Sulphur Springs
12
12
Little Belts Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Inventoried Roadless Areas
Big Baldy
Bluff Mountain
Calf Creek
Eagle Park
Granite Mountain
Middle Fork Judith
Mount High
North Fork Smith
Paine Gulch
Pilgrim Creek
Sawmill Creek
Spring Creek
Tenderfoot - Deep Creek
Tollgate - Sheep
Tw Mountain
Spring 2018
N
0
5
10
20
Miles
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Range Allotments
Little Belts Geographic Area
Map LB-22
Little Belts Geographic Area Boundary
National Forest System Land
Non-National Forest System Land
LB Range Allotment with Unit Numbers
Spring 2018
Stanford
White Sulphur Springs
89
87
12
Helena - Lewis and Clark National Forest
Forest Plan - Draft Environmental Impact Statement
0 5 10 20
Miles
N

Lands Where Harvest Could Occur - Alternative A
Little Belts Geographic Area

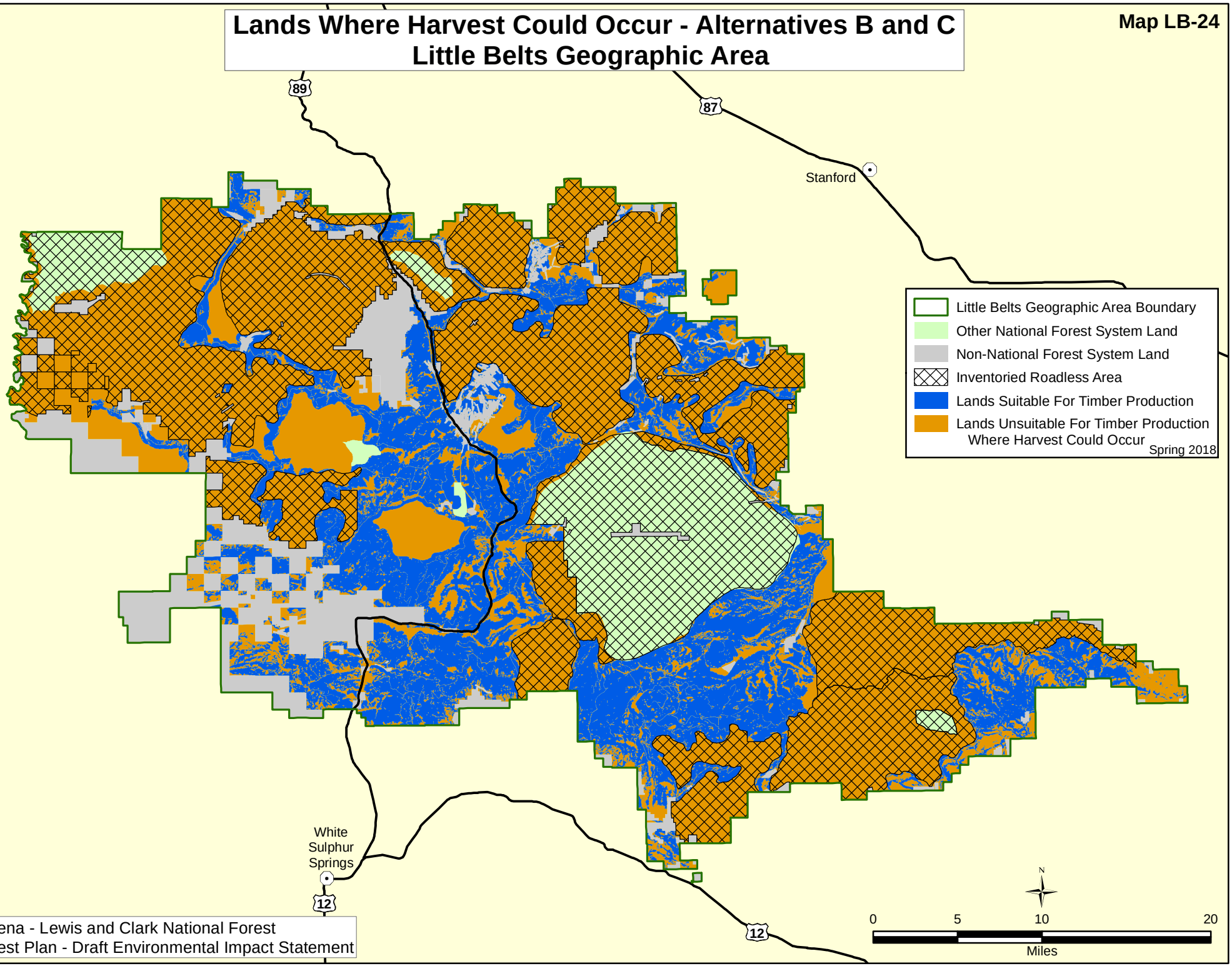
Map LB-23



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Lands Where Harvest Could Occur - Alternatives B and C
Little Belts Geographic Area

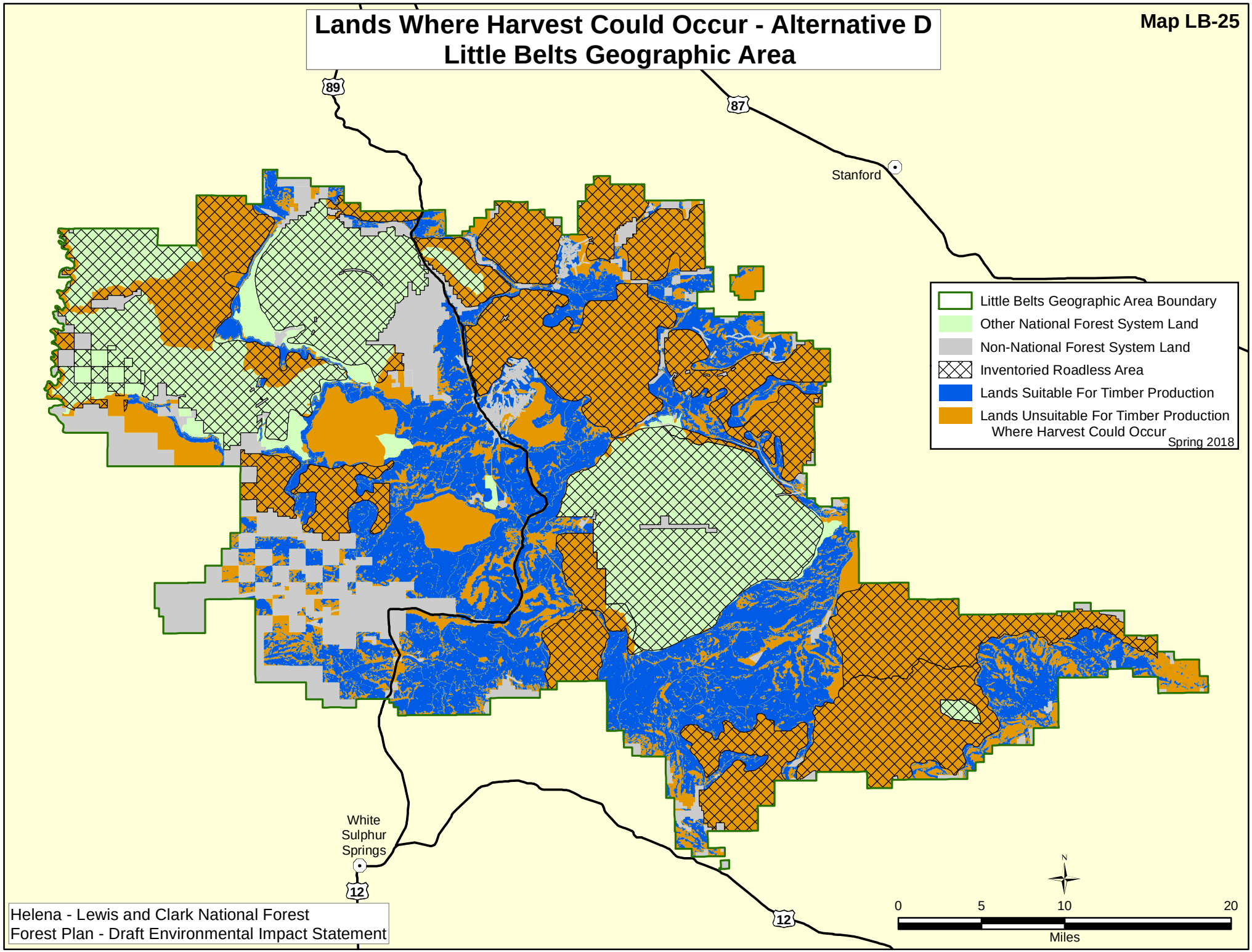
Map LB-24



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Lands Where Harvest Could Occur - Alternative D
Little Belts Geographic Area

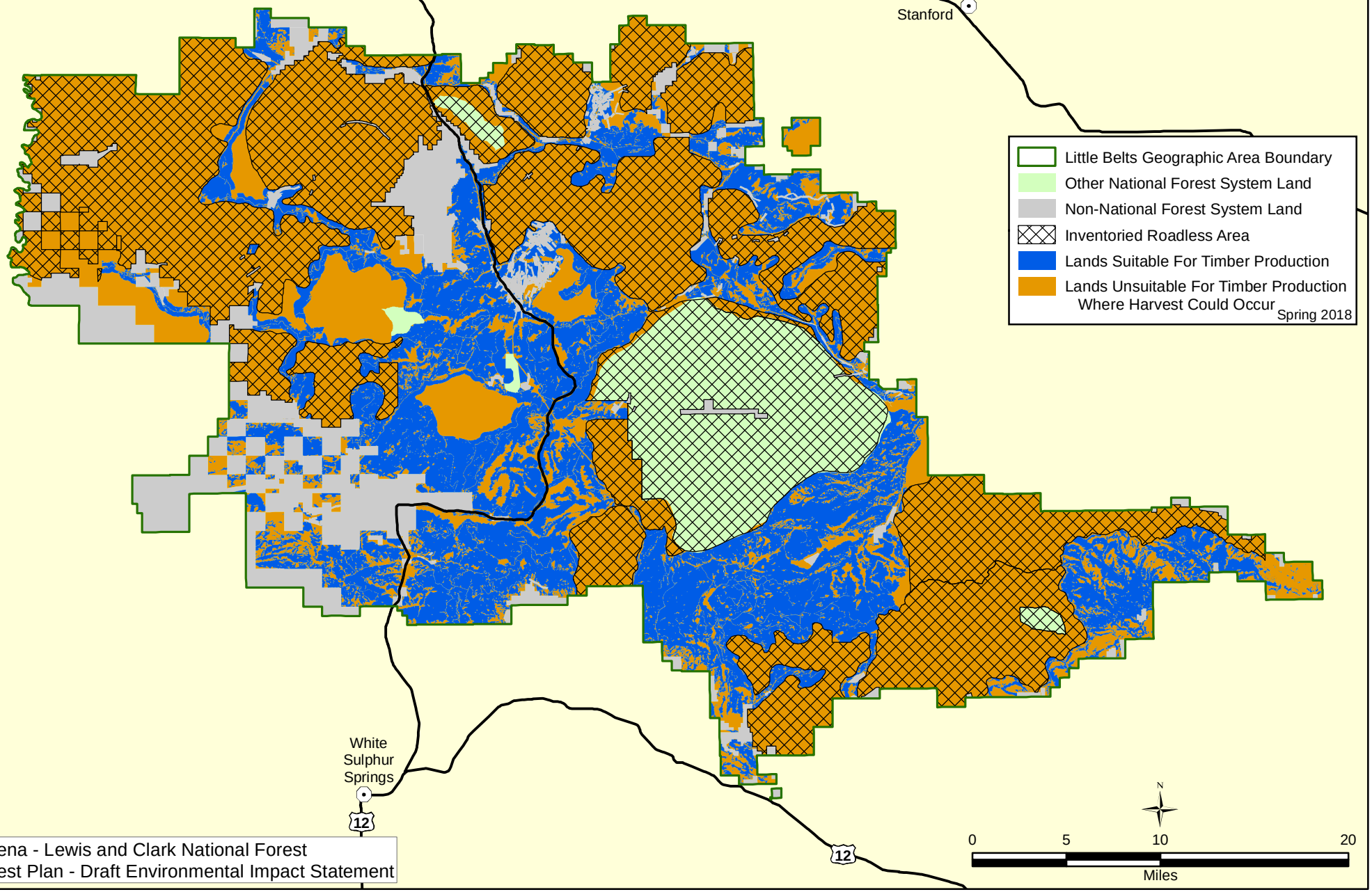
Map LB-25



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Lands Where Harvest Could Occur - Alternative E
Little Belts Geographic Area

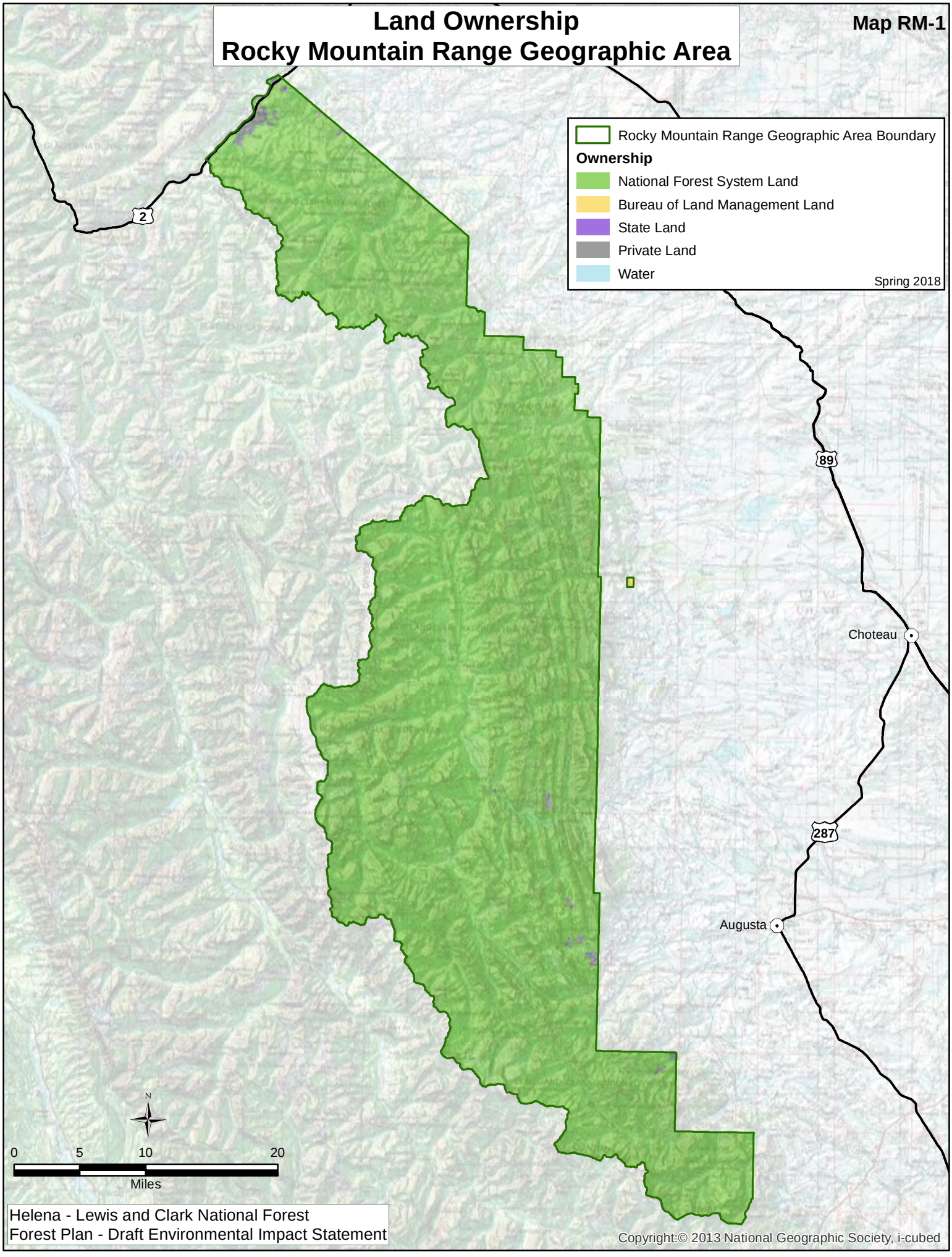
Map LB-26



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Land Ownership
Rocky Mountain Range Geographic Area

Map RM-1

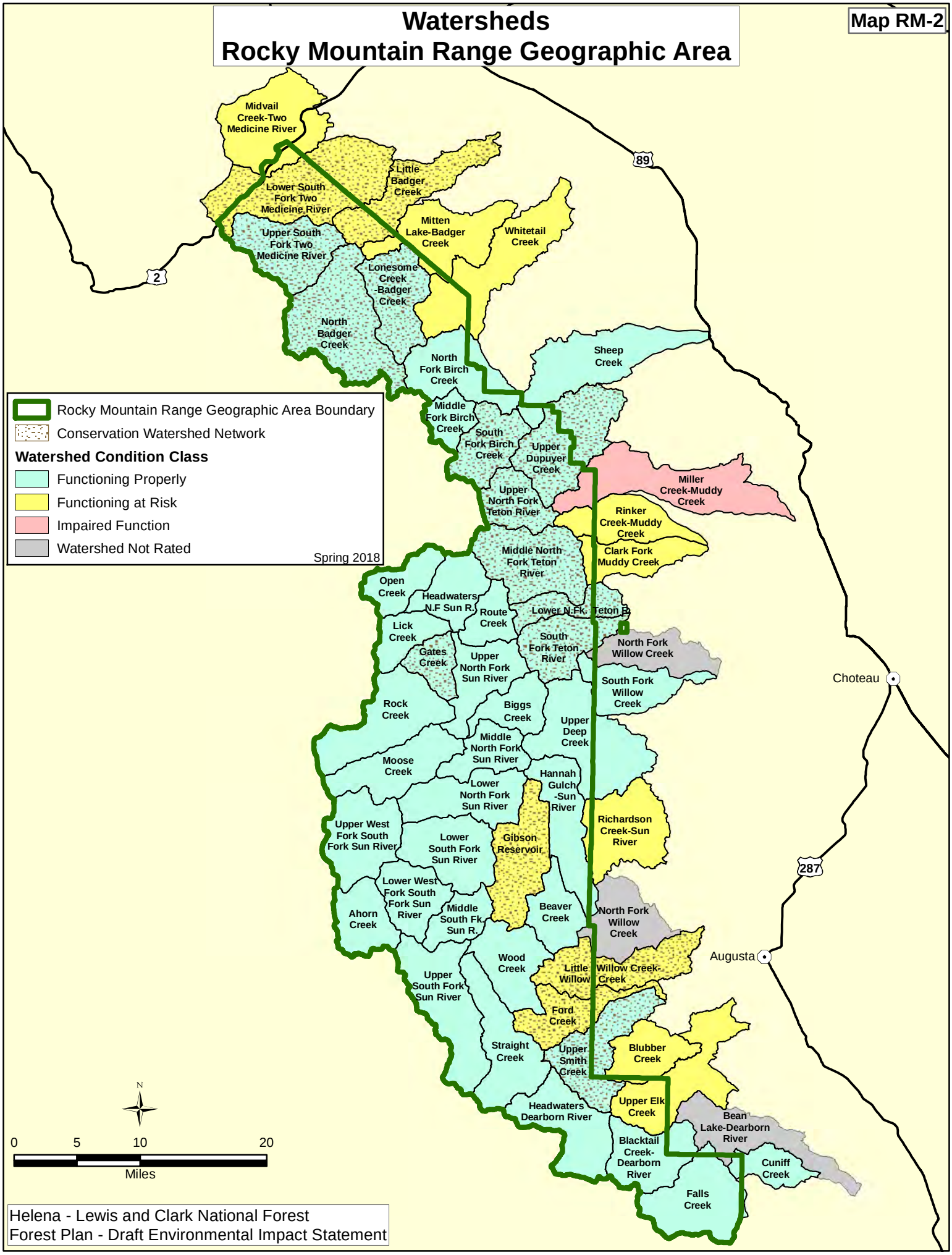


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Watersheds
Rocky Mountain Range Geographic Area

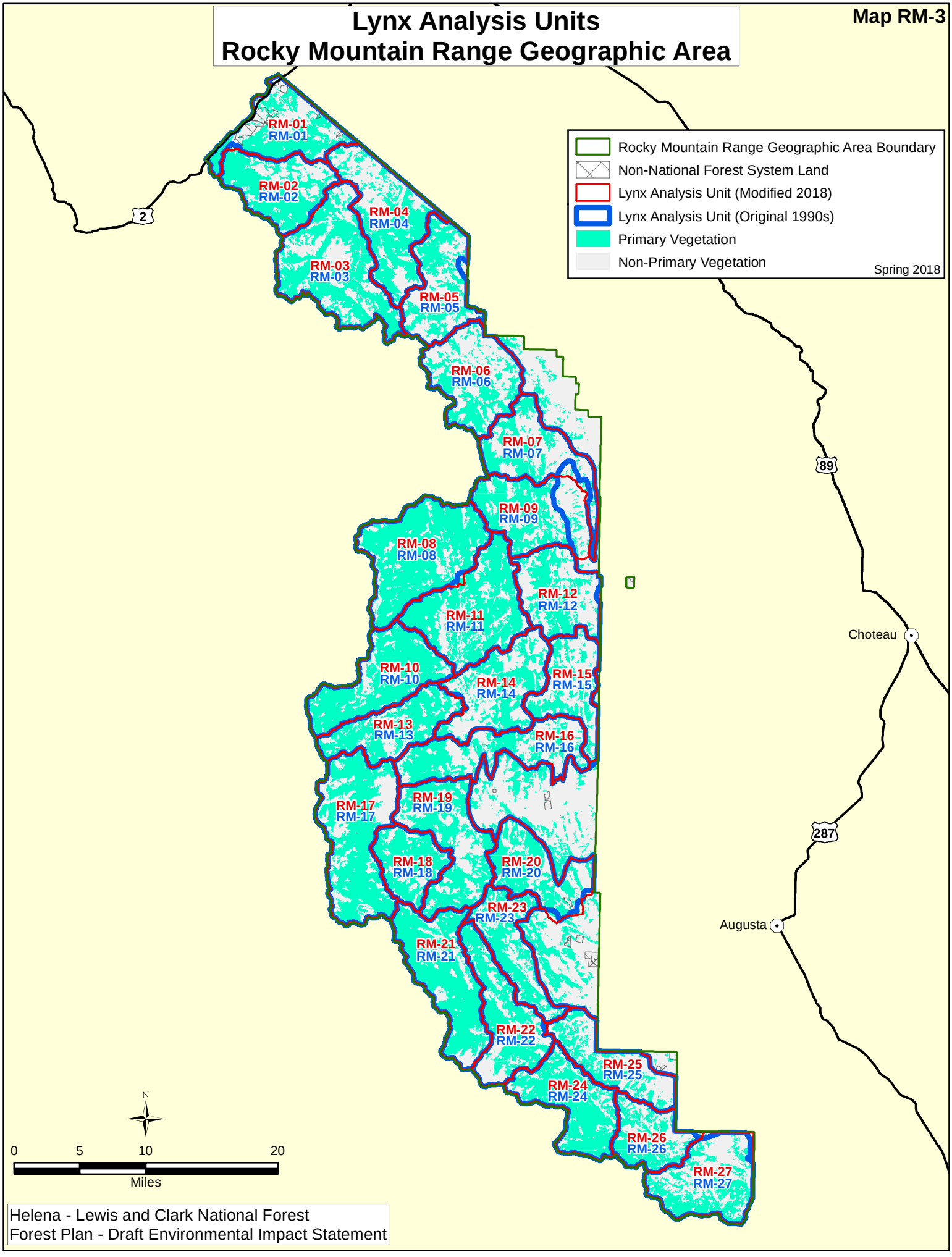
Map RM-2



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Lynx Analysis Units
Rocky Mountain Range Geographic Area

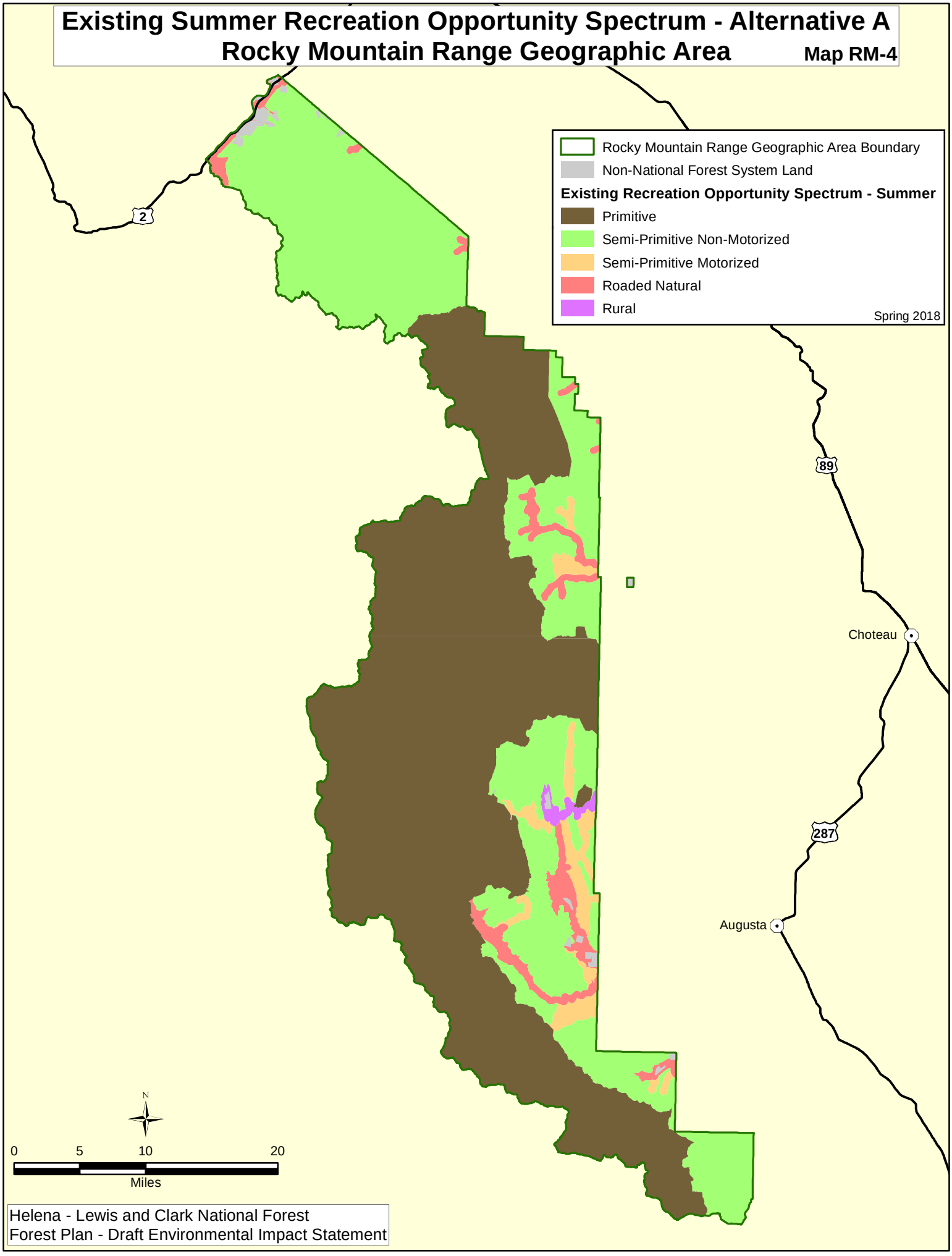
Map RM-3



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Existing Summer Recreation Opportunity Spectrum - Alternative A
Rocky Mountain Range Geographic Area

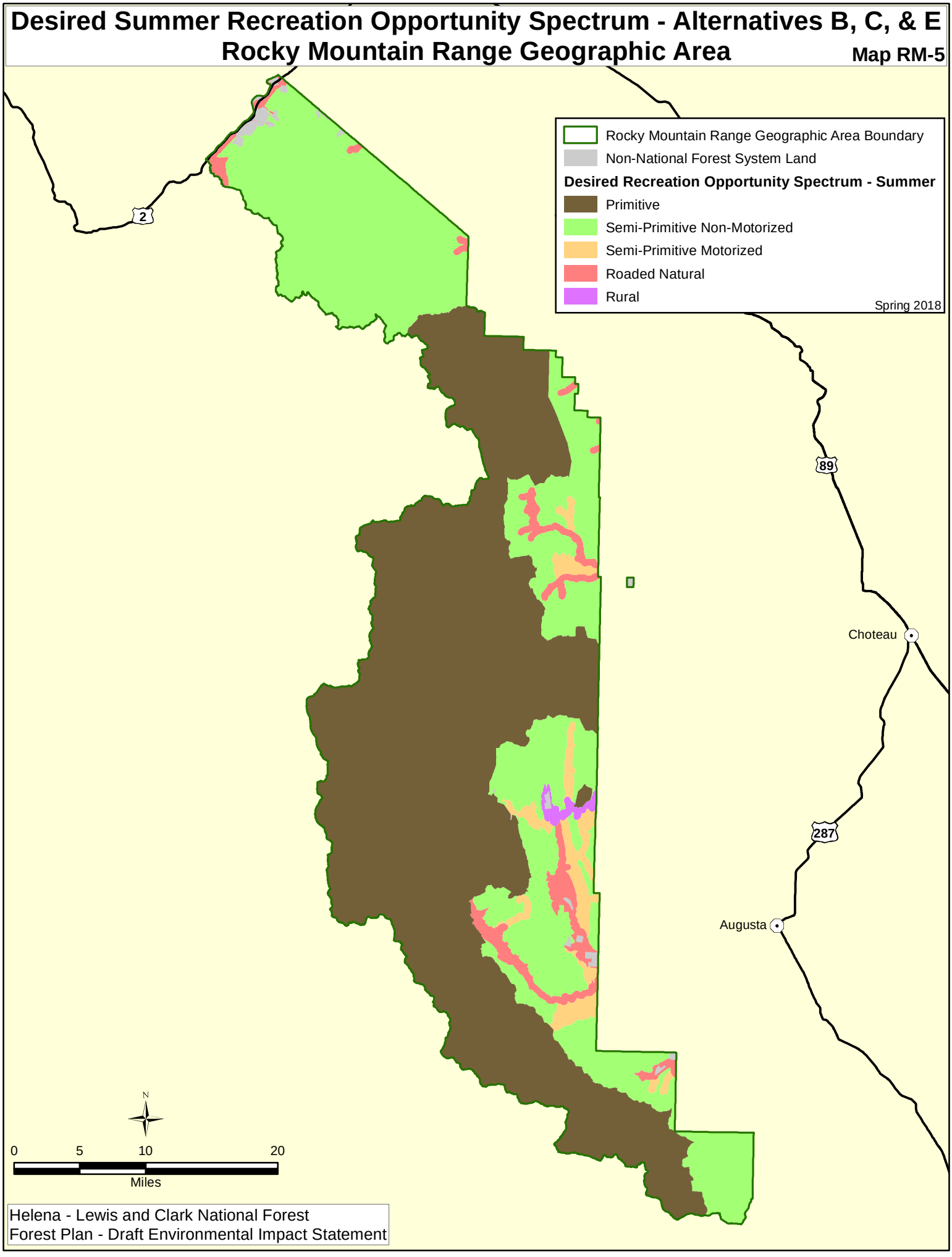
Map RM-4



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Desired Summer Recreation Opportunity Spectrum - Alternatives B, C, & E
Rocky Mountain Range Geographic Area

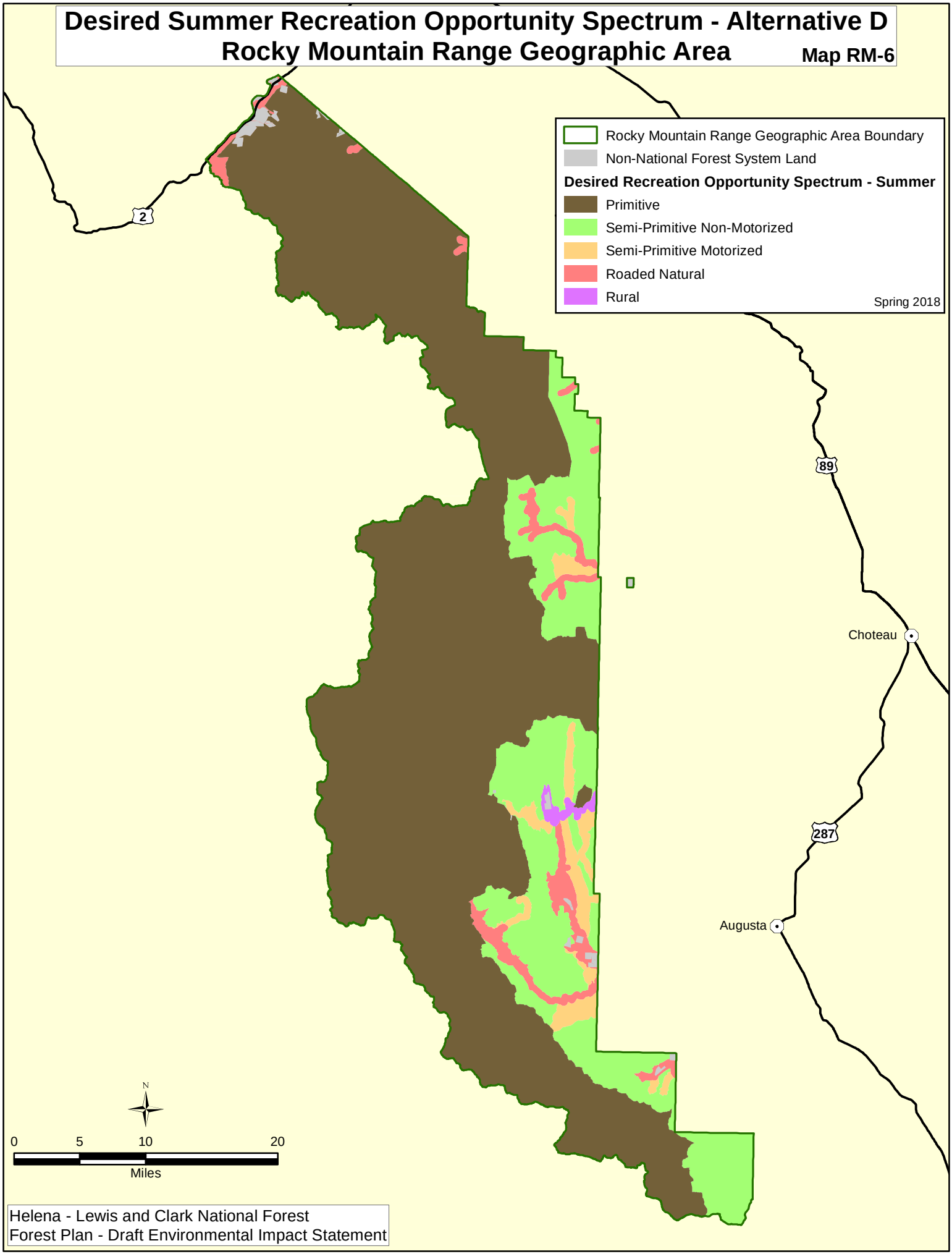
Map RM-5



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Desired Summer Recreation Opportunity Spectrum - Alternative D
Rocky Mountain Range Geographic Area

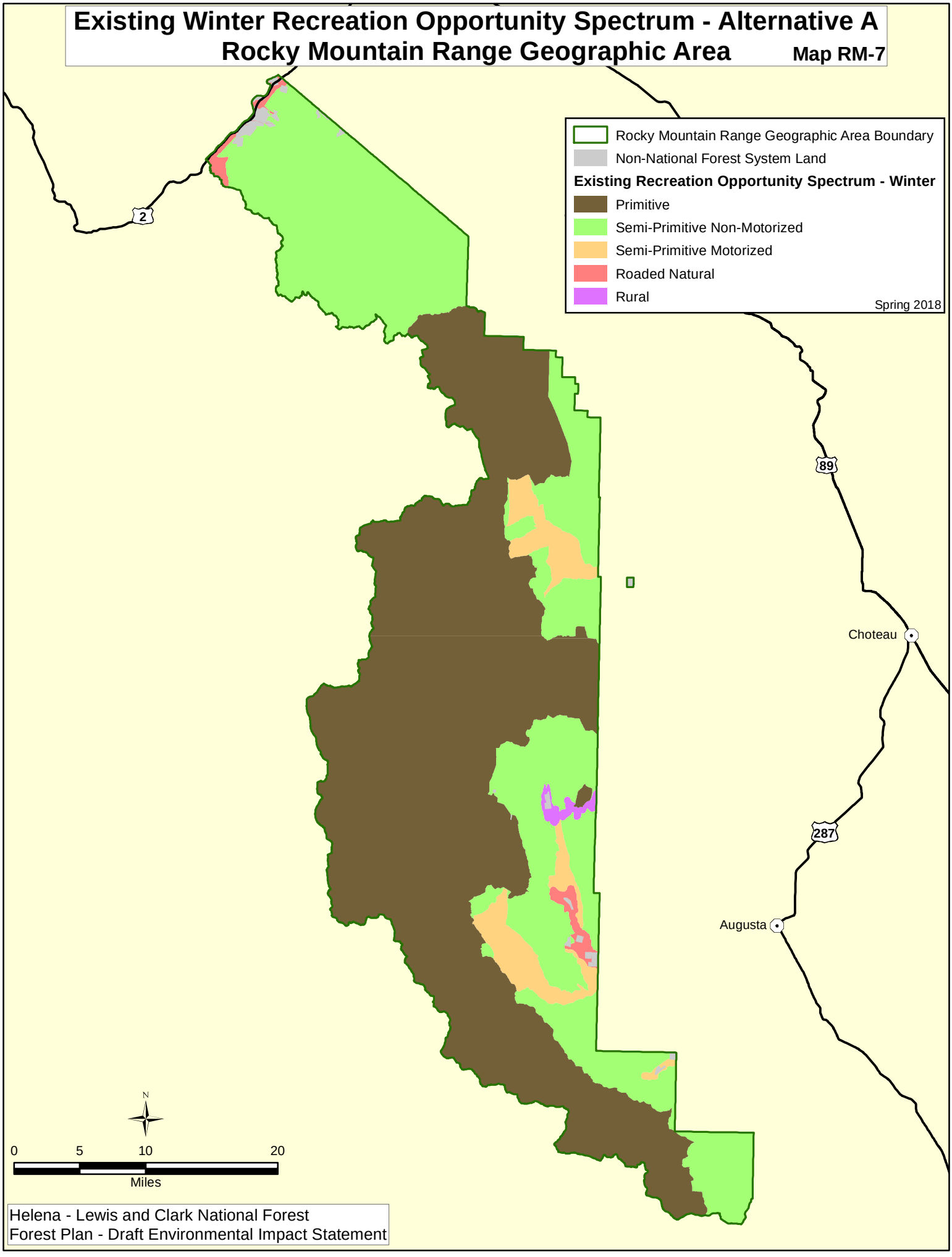
Map RM-6



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Rocky Mountain Range Geographic Area

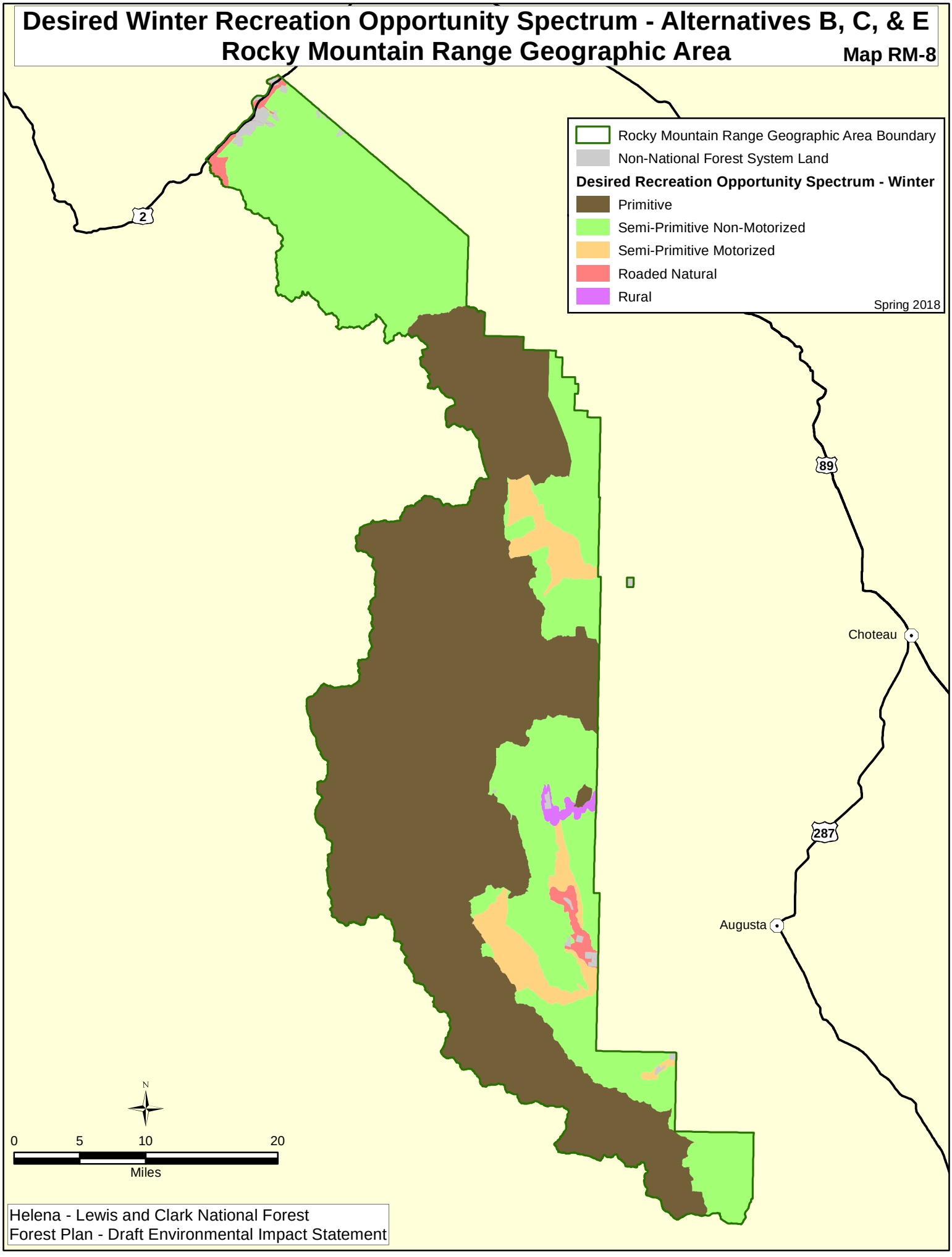
Map RM-7



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Desired Winter Recreation Opportunity Spectrum - Alternatives B, C, & E
Rocky Mountain Range Geographic Area

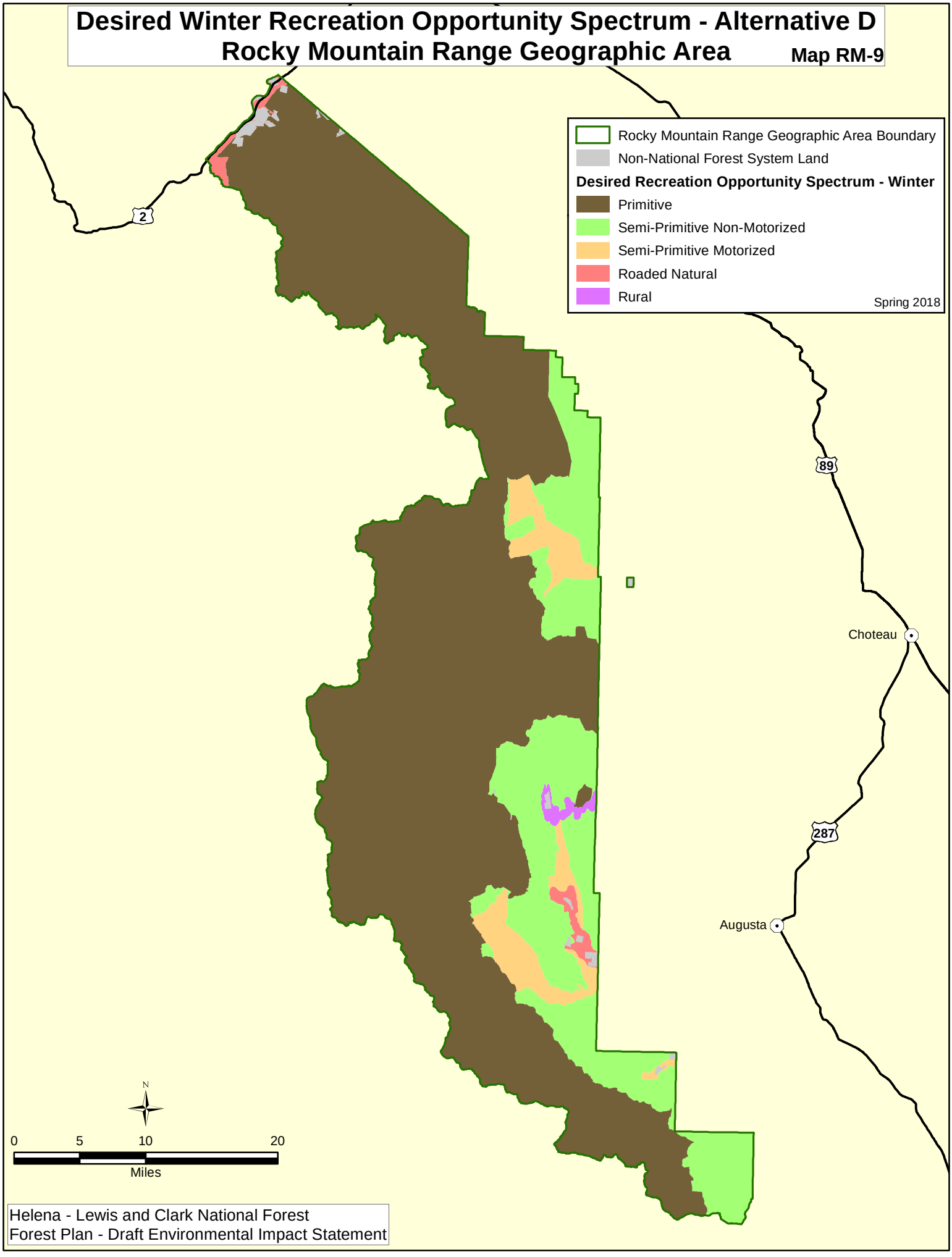
Map RM-8



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Desired Winter Recreation Opportunity Spectrum - Alternative D
Rocky Mountain Range Geographic Area

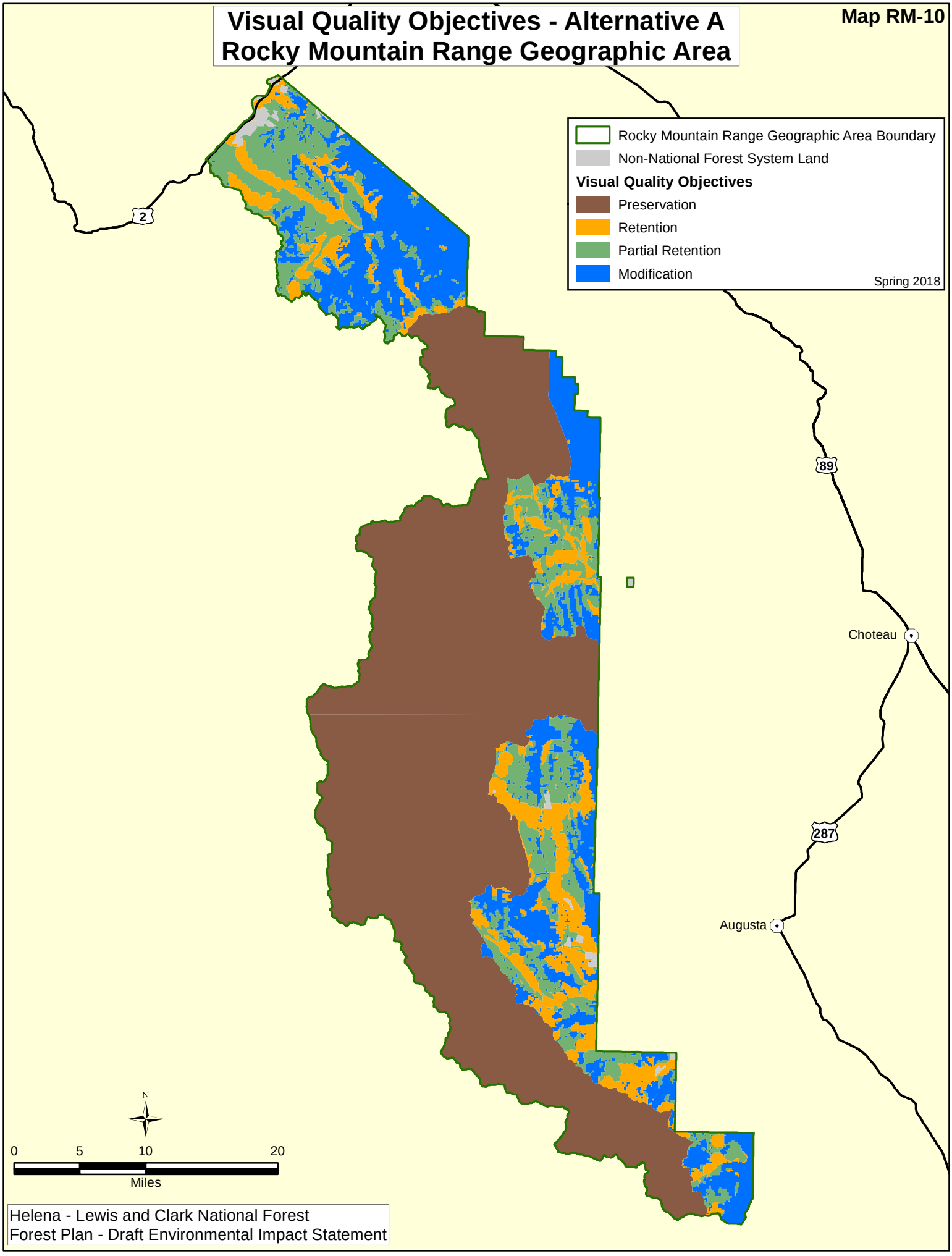
Map RM-9



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Visual Quality Objectives - Alternative A
Rocky Mountain Range Geographic Area

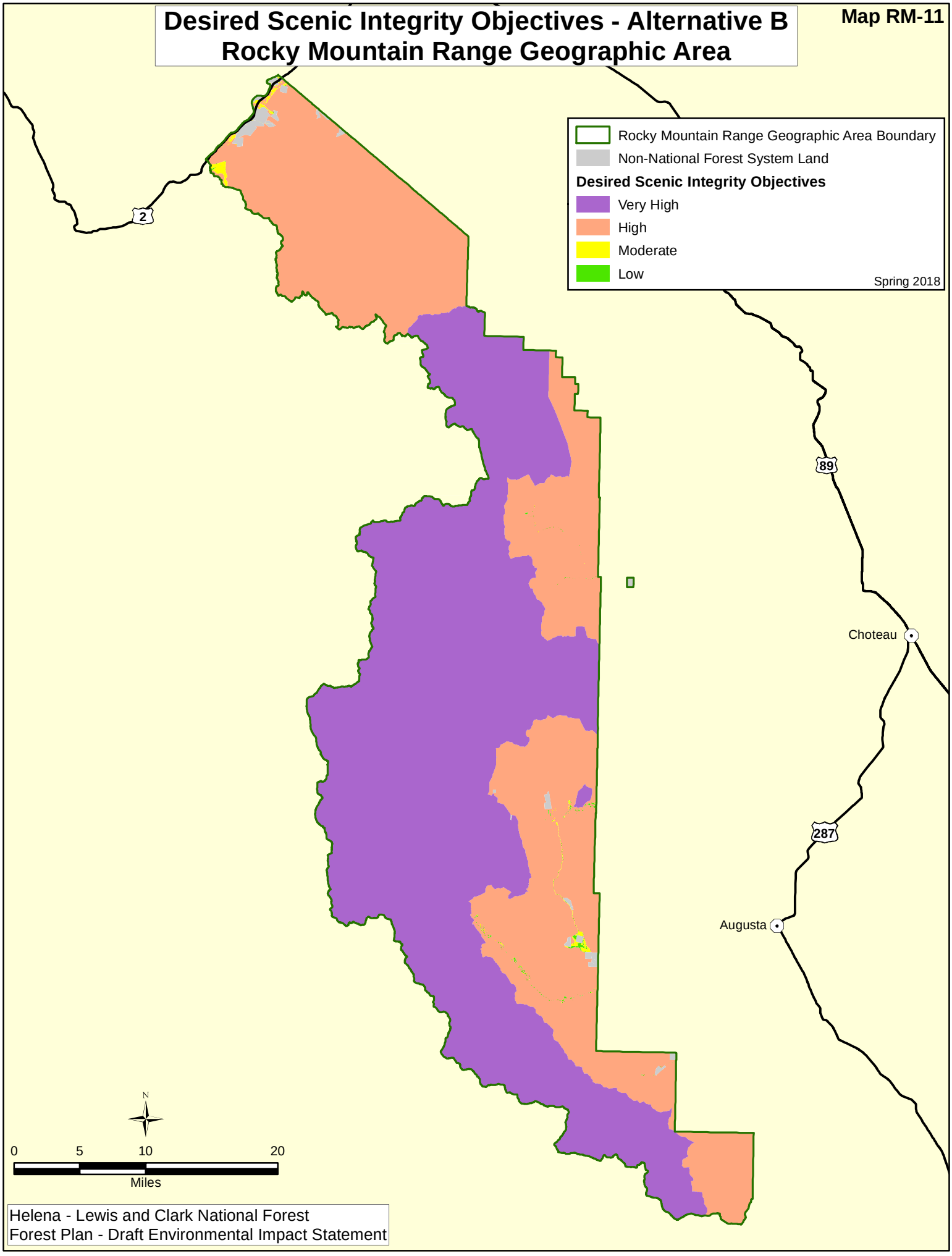
Map RM-10



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Desired Scenic Integrity Objectives - Alternative B
Rocky Mountain Range Geographic Area

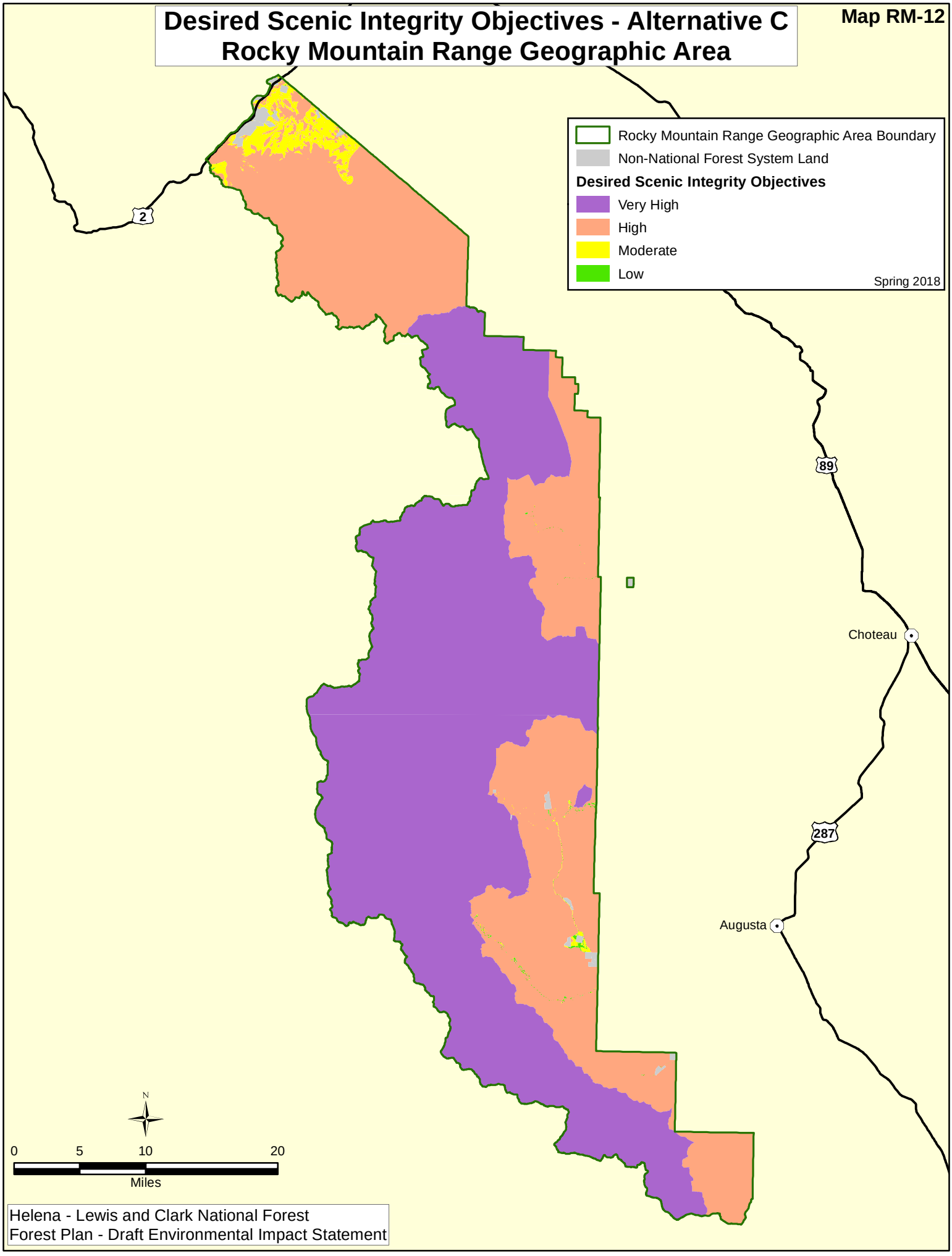
Map RM-11



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Desired Scenic Integrity Objectives - Alternative C
Rocky Mountain Range Geographic Area

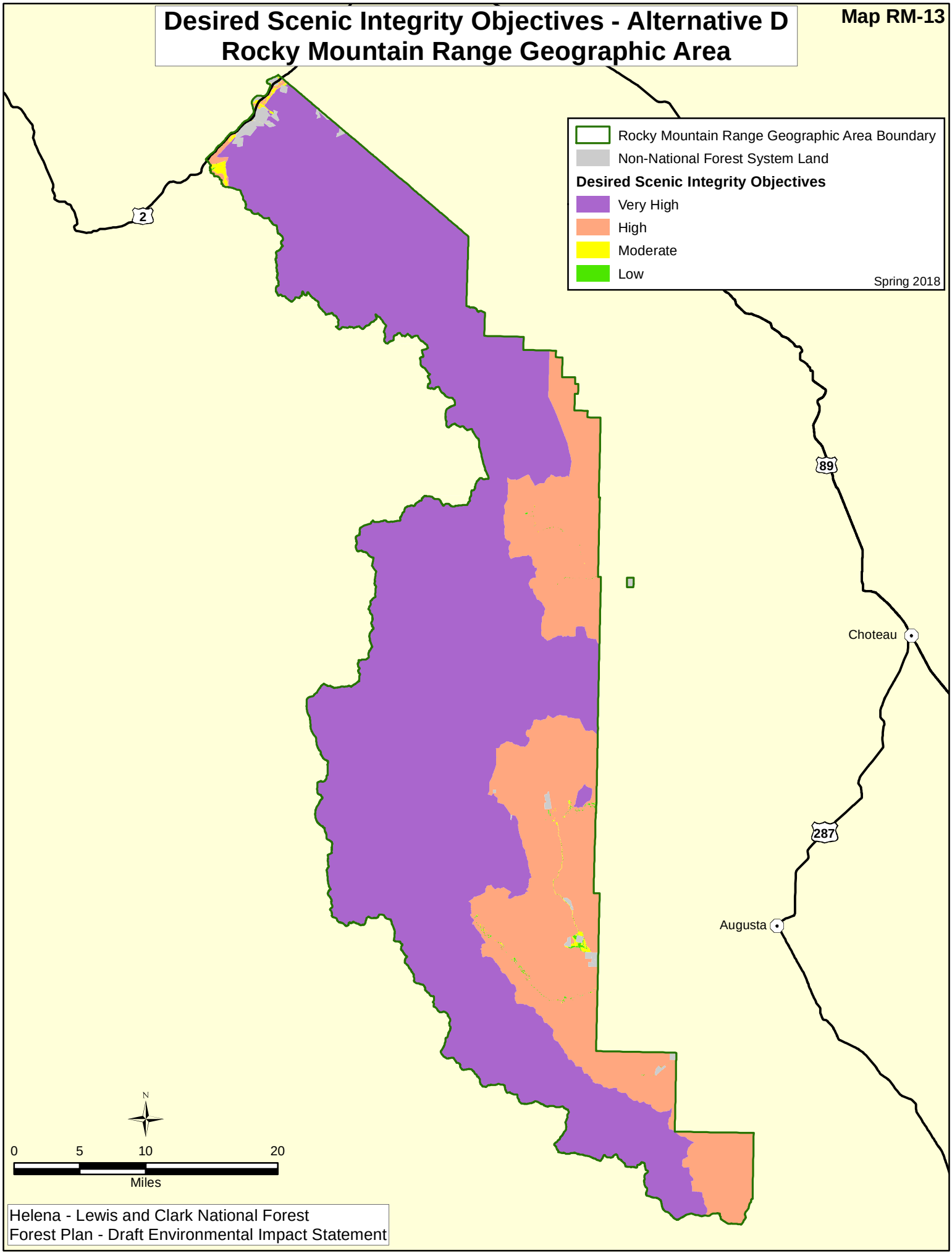
Map RM-12



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Desired Scenic Integrity Objectives - Alternative D
Rocky Mountain Range Geographic Area

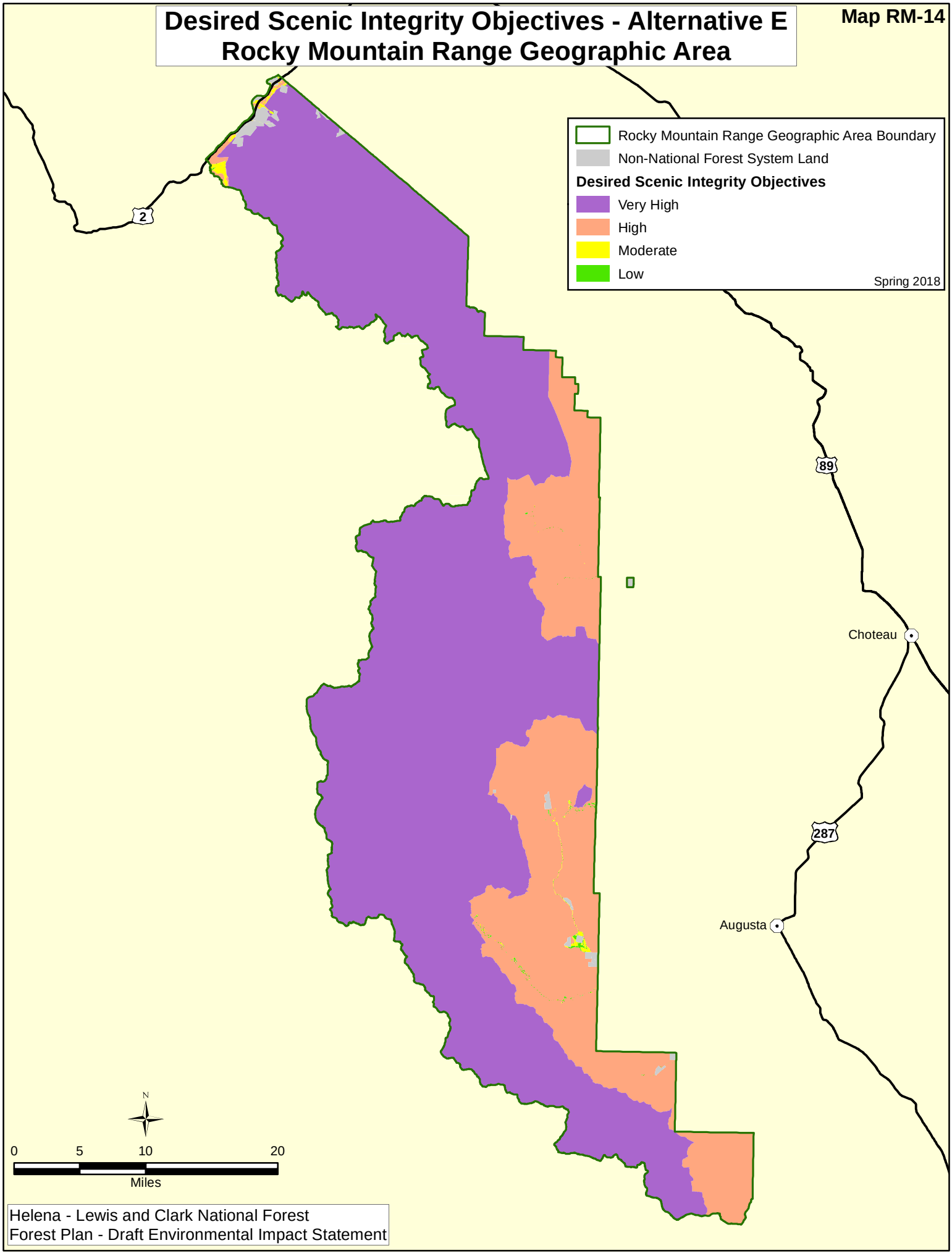
Map RM-13



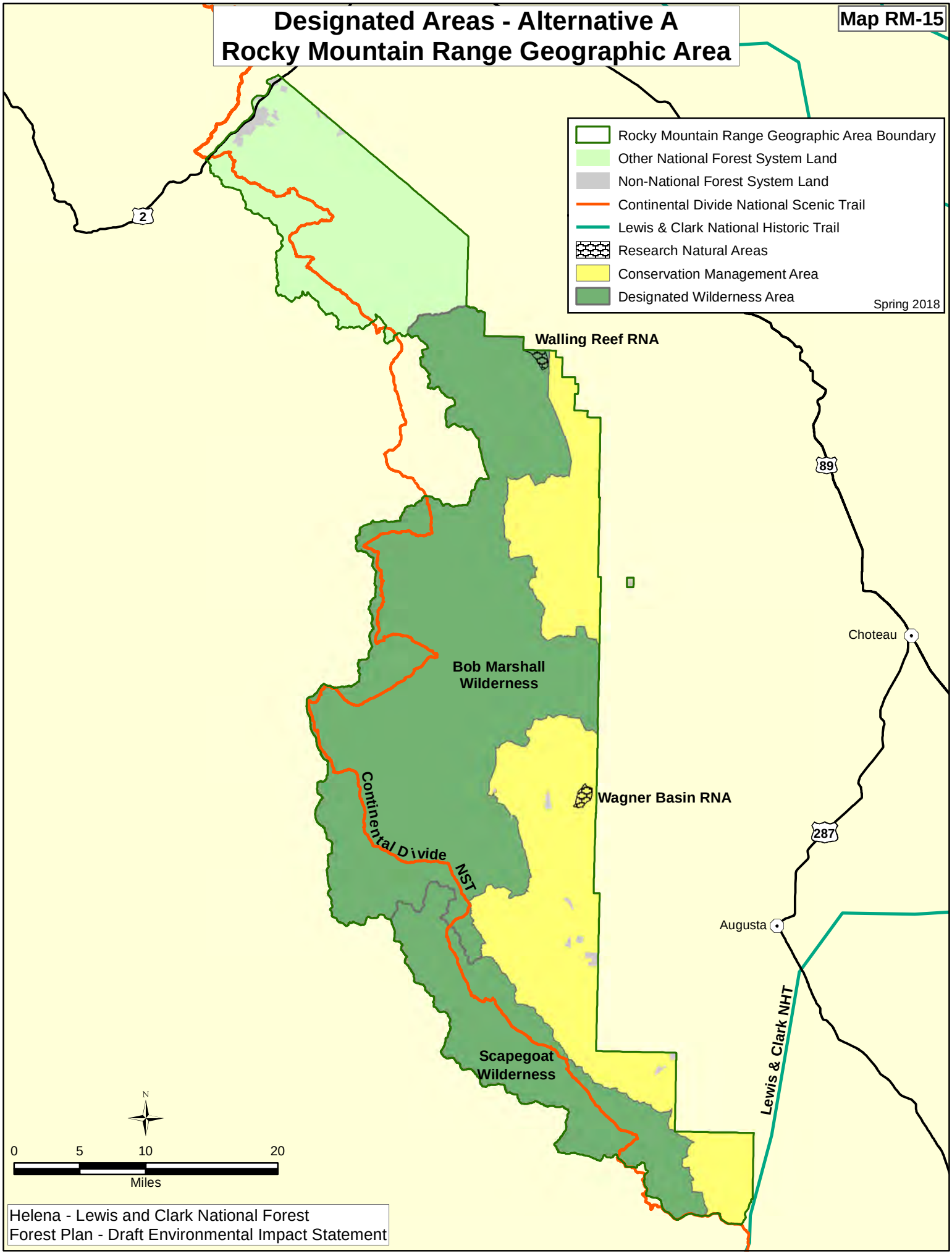
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Desired Scenic Integrity Objectives - Alternative E
Rocky Mountain Range Geographic Area

Map RM-14

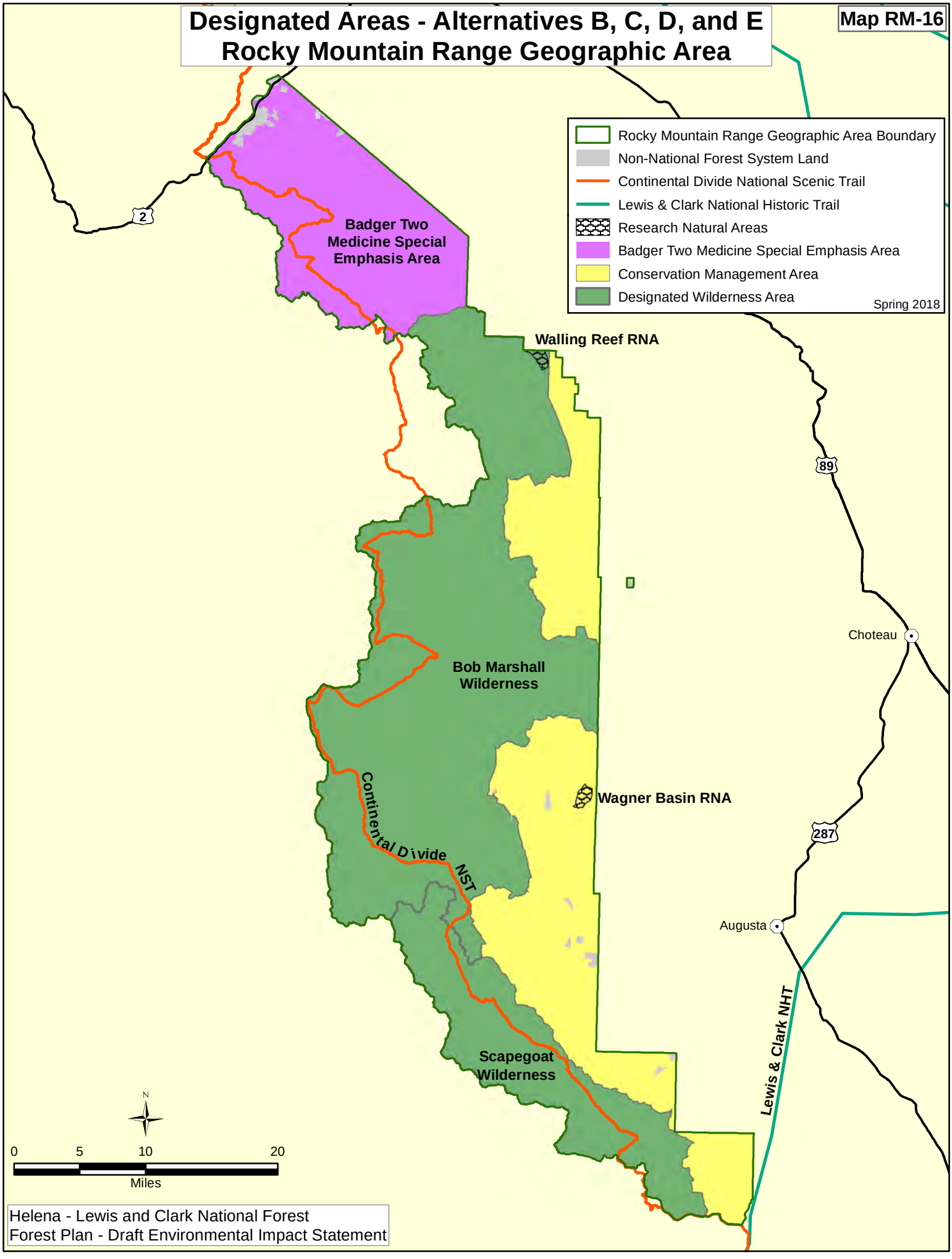


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Designated Areas - Alternative A
Rocky Mountain Range Geographic Area
Map RM-15
Rocky Mountain Range Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Continental Divide National Scenic Trail
Lewis & Clark National Historic Trail
Research Natural Areas
Conservation Management Area
Designated Wilderness Area
Spring 2018
Walling Reef RNA
Bob Marshall Wilderness
Wagner Basin RNA
Continental Divide NST
Scapegoat Wilderness
Lewis & Clark NHT
Choteau
Augusta
2
89
287
N
0
5
10
20
Miles
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Designated Areas - Alternatives B, C, D, and E
Rocky Mountain Range Geographic Area

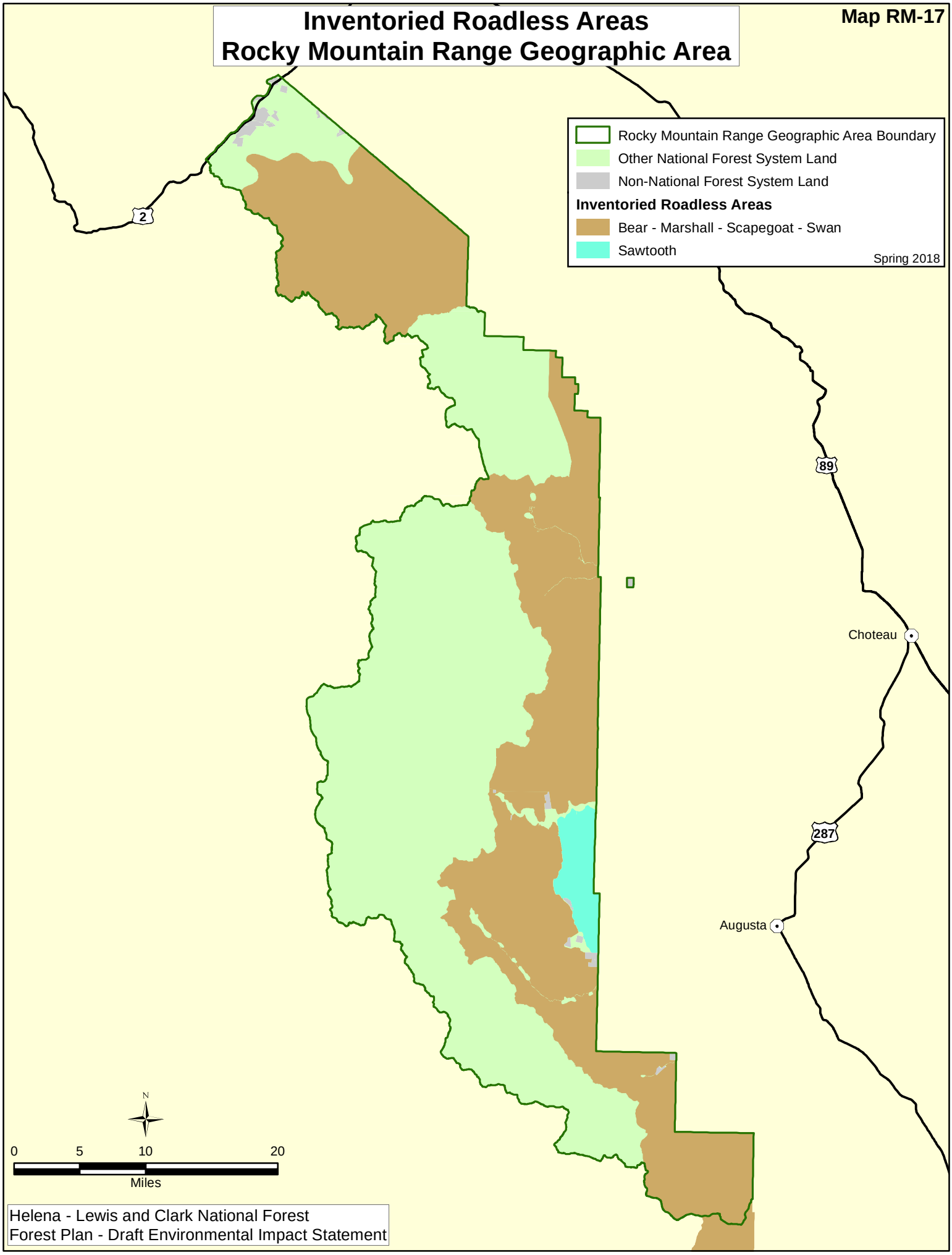
Map RM-16



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Inventoried Roadless Areas
Rocky Mountain Range Geographic Area

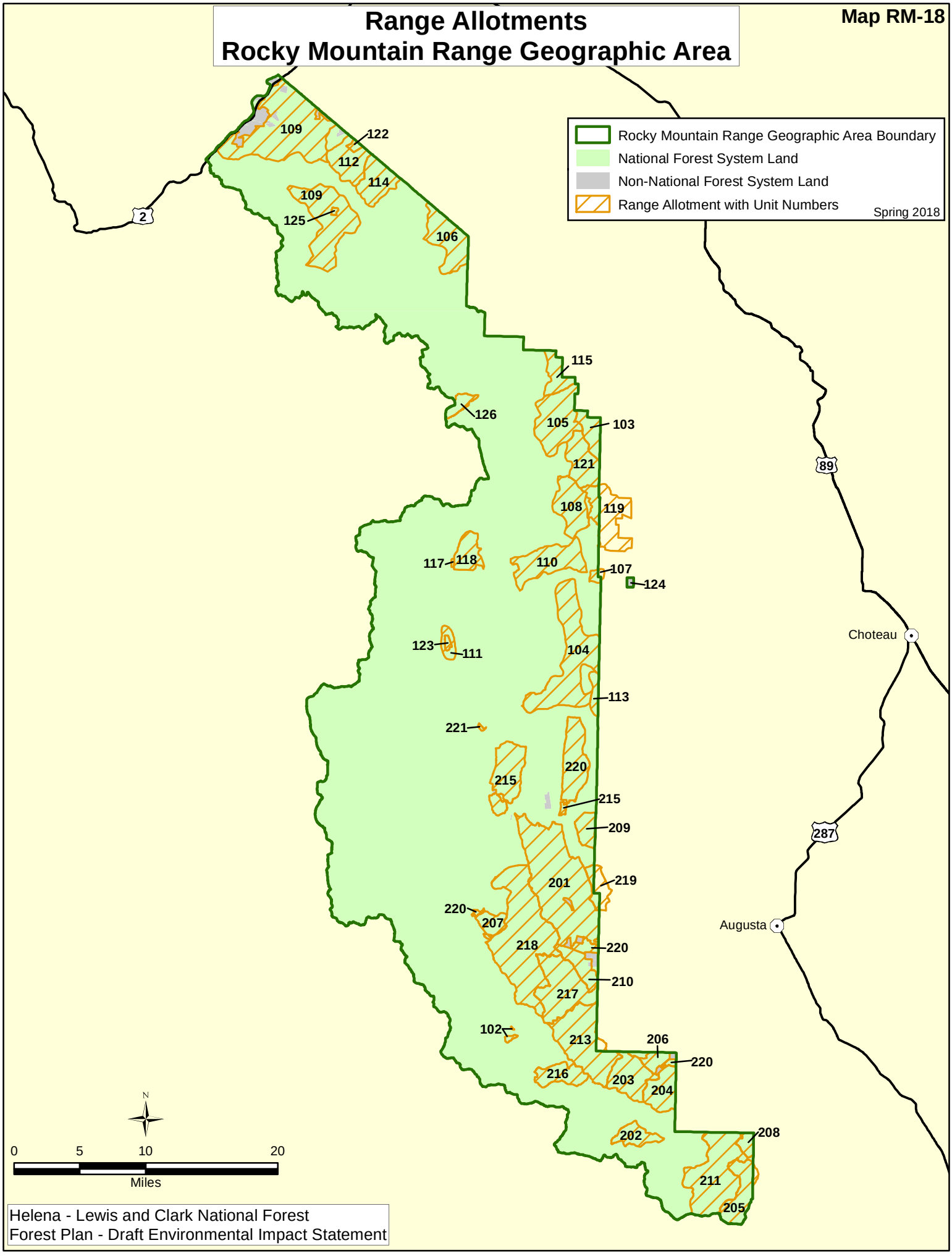
Map RM-17



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Range Allotments
Rocky Mountain Range Geographic Area

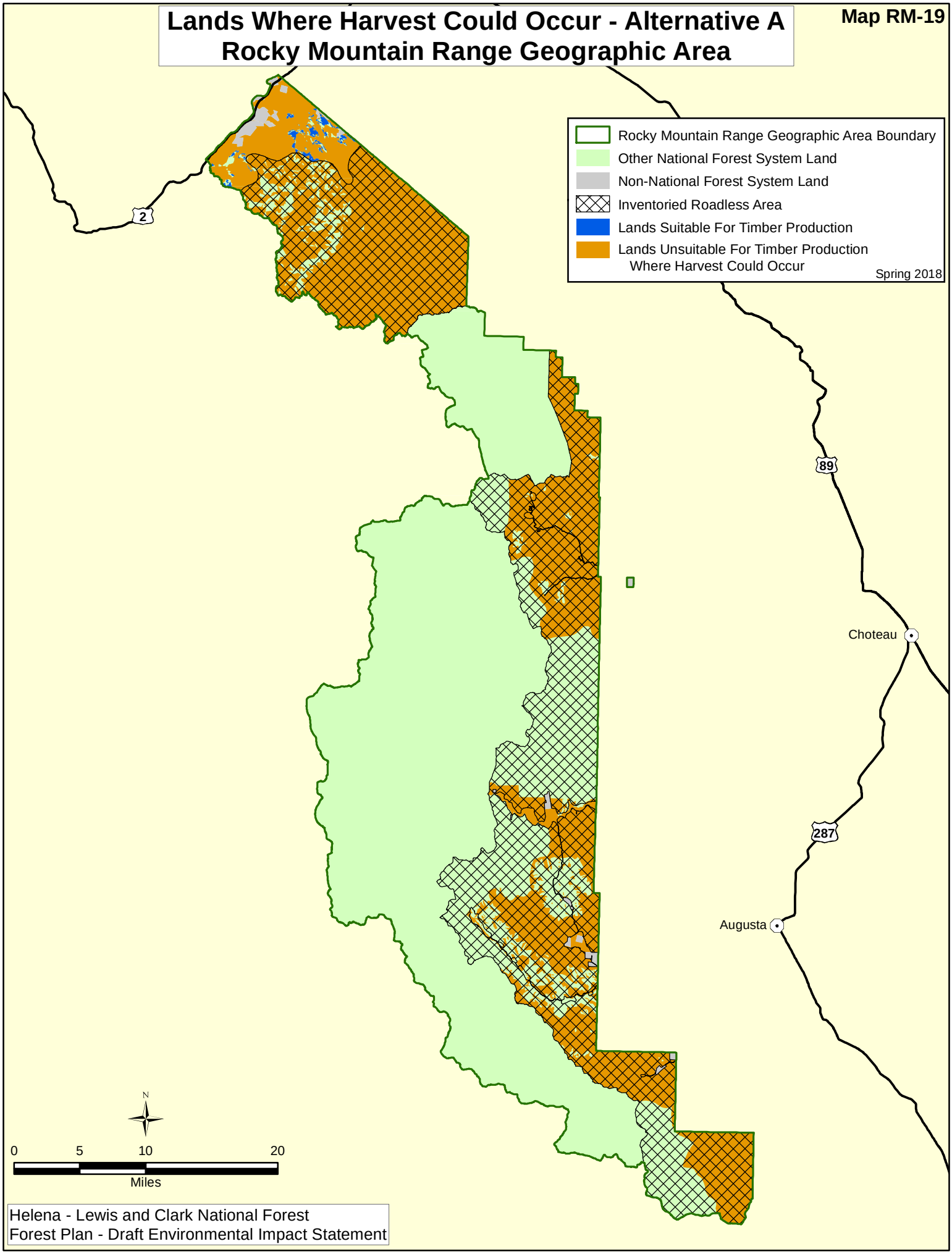
Map RM-18



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Lands Where Harvest Could Occur - Alternative A
Rocky Mountain Range Geographic Area

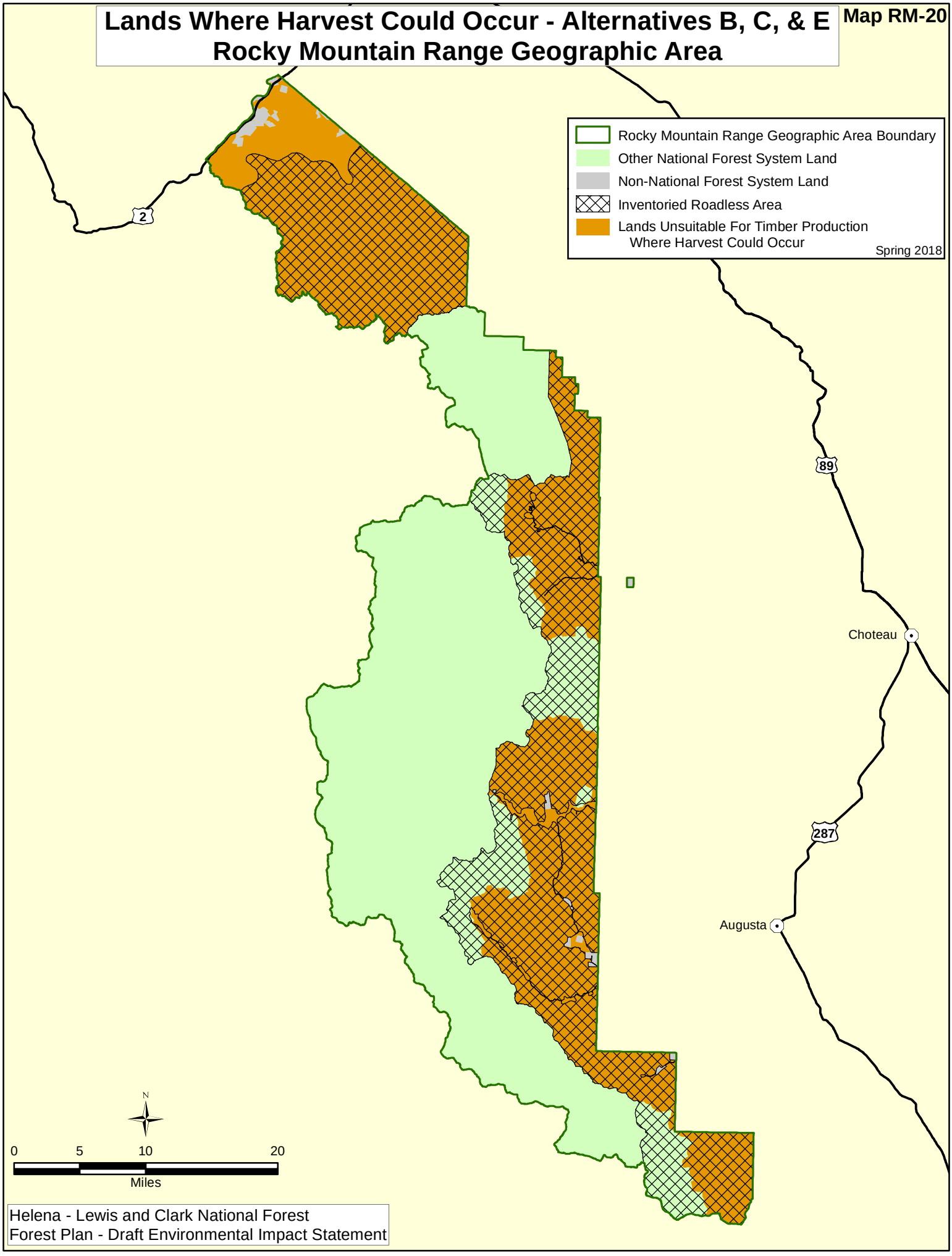
Map RM-19



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Lands Where Harvest Could Occur - Alternatives B, C, & E
Rocky Mountain Range Geographic Area

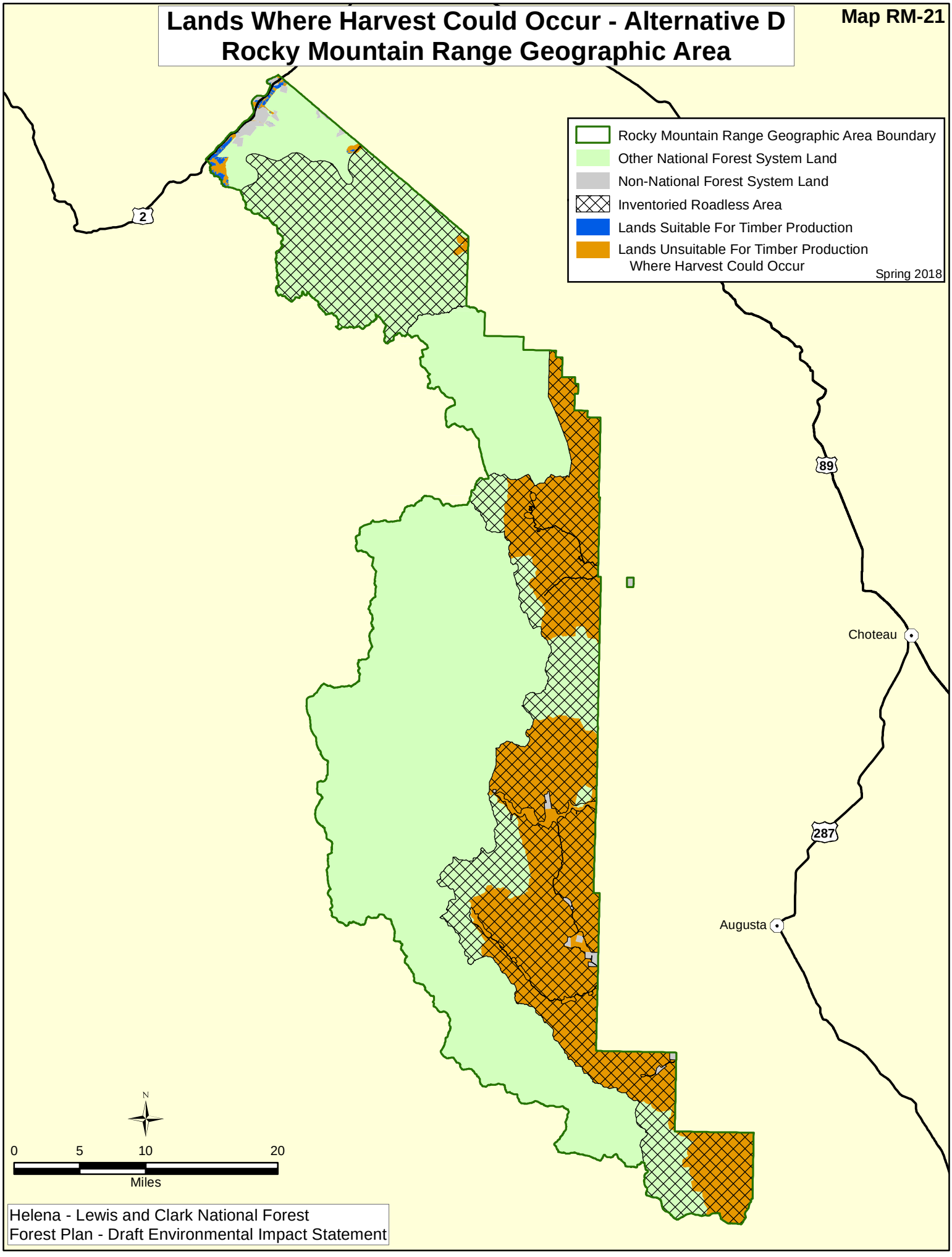
Map RM-20



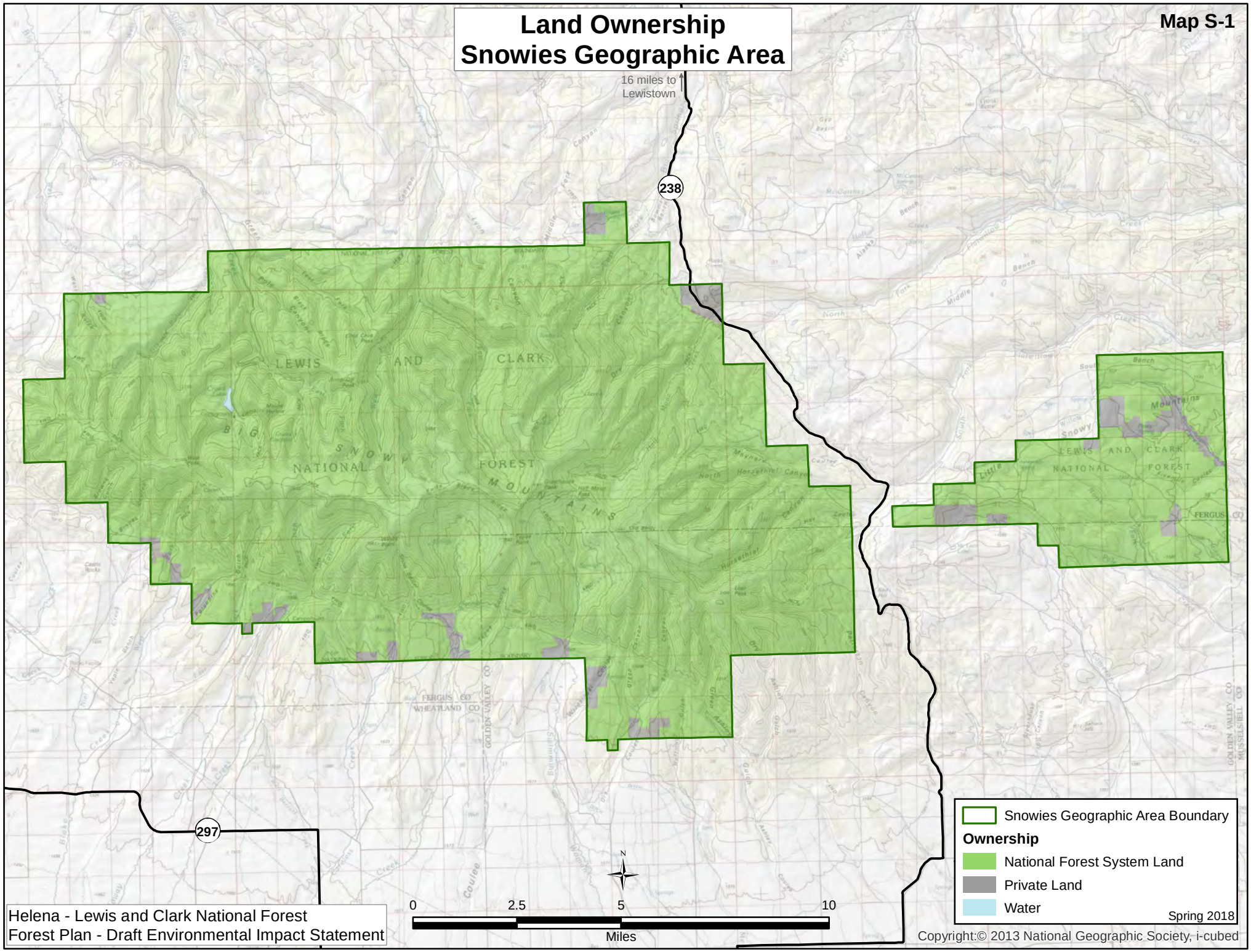
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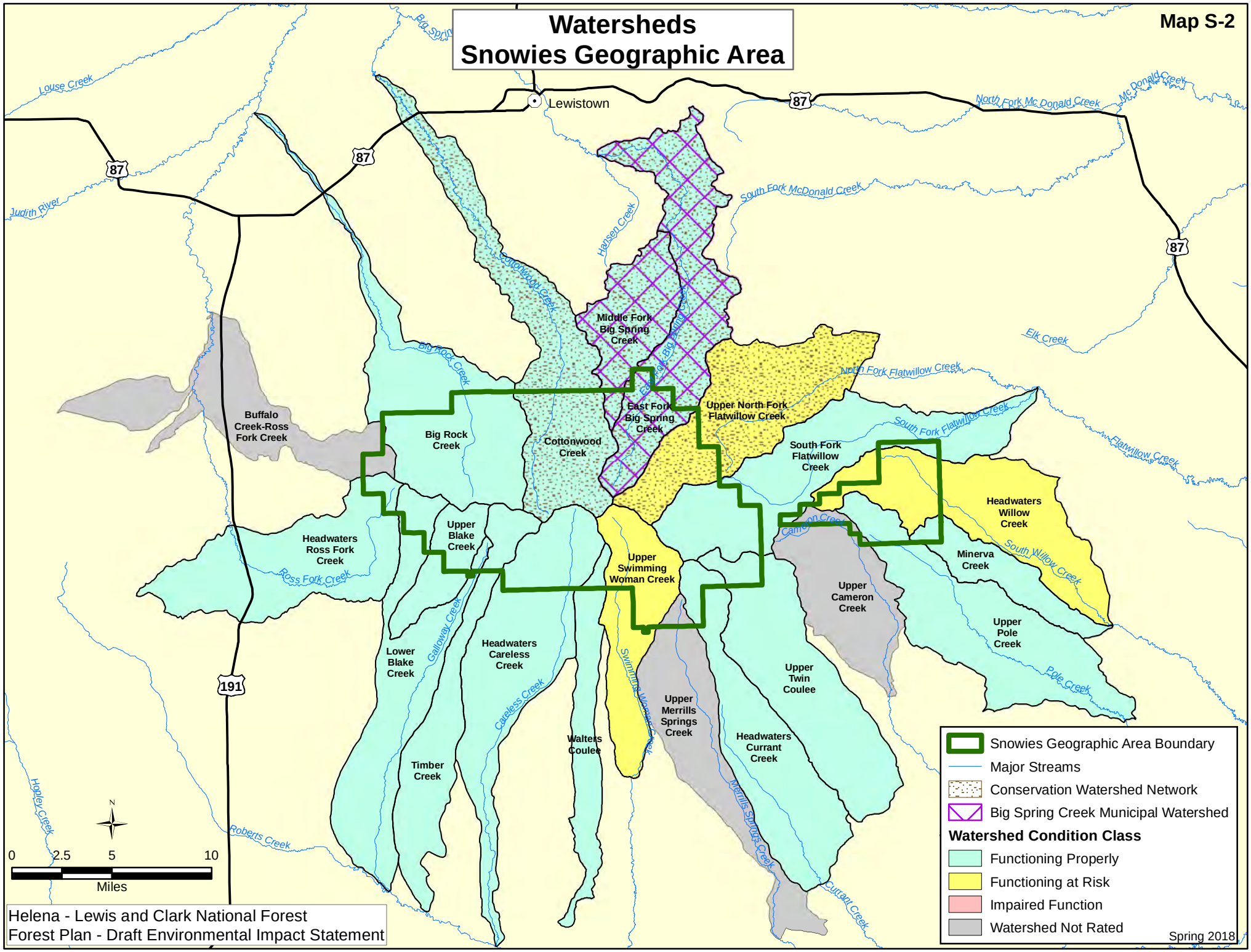
Lands Where Harvest Could Occur - Alternative D
Rocky Mountain Range Geographic Area

Map RM-21



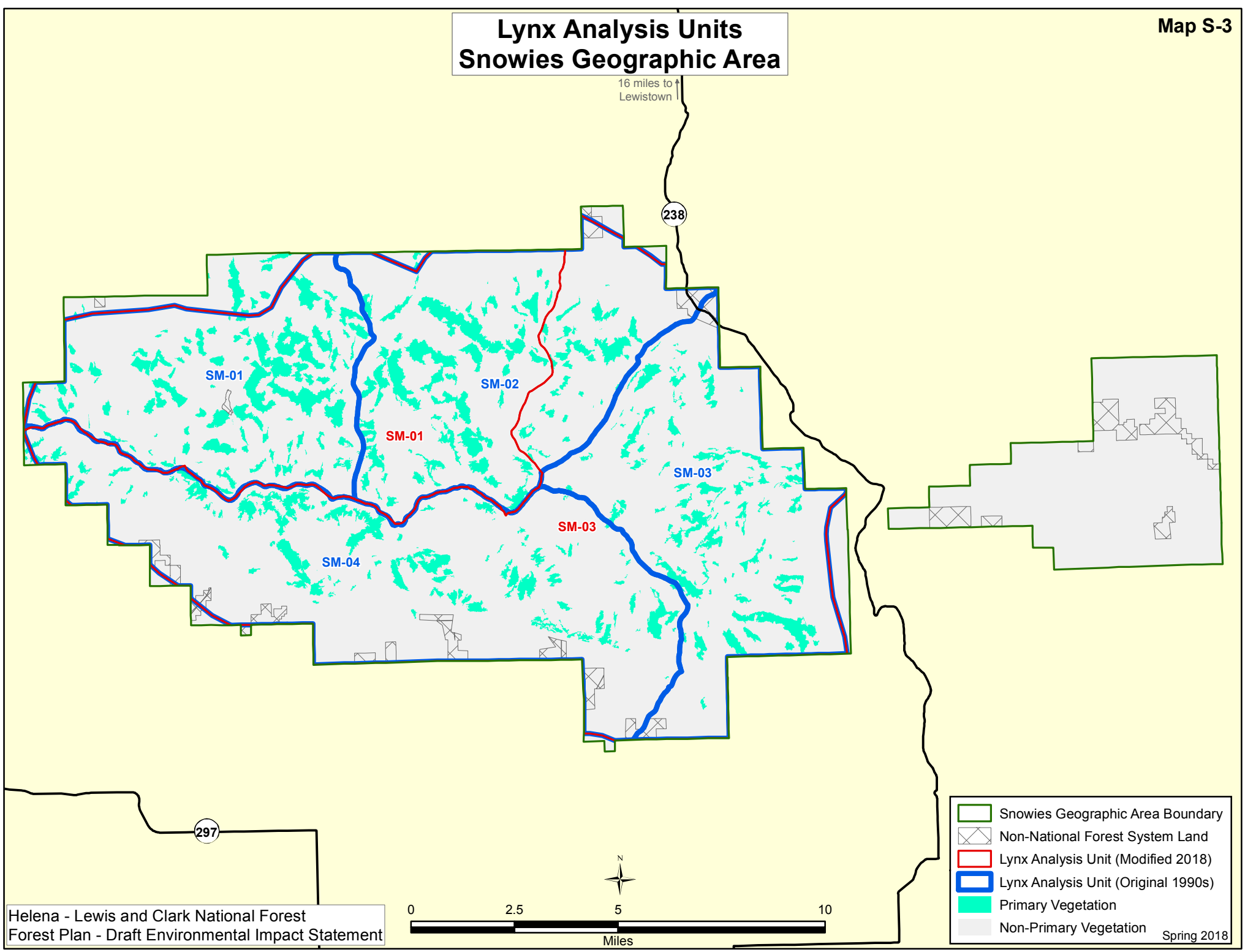
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Land Ownership
Snowies Geographic Area
Map S-1
16 miles to Lewistown
238
297
LEWIS AND CLARK
NATIONAL FOREST
BIG SNOWY MOUNTAINS
Snowy Mountains
LEWIS AND CLARK NATIONAL FOREST
FERGUS CO
WHEATLAND CO
GOLDEN VALLEY CO
MUSSELSHELL CO
Snowies Geographic Area Boundary
Ownership
National Forest System Land
Private Land
Water
Spring 2018
N
0
2.5
5
10
Miles
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Watersheds
Snowies Geographic Area
Map S-2
Lewistown
87
191
Louse Creek
Judith River
Big Spring Creek
Cottonwood Creek
Hansen Creek
North Fork Mc Donald Creek
Mc Donald Creek
South Fork McDonald Creek
Elk Creek
North Fork Flatwillow Creek
South Fork Flatwillow Creek
Flatwillow Creek
Big Rock Creek
Ross Fork Creek
Galloway Creek
Careless Creek
Swimming Woman Creek
Cameron Creek
South Willow Creek
Pole Creek
Merrills Springs Creek
Currant Creek
Roberts Creek
Hobley Creek
Middle Fork Big Spring Creek
East Fork Big Spring Creek
Upper North Fork Flatwillow Creek
Buffalo Creek-Ross Fork Creek
Big Rock Creek
Cottonwood Creek
South Fork Flatwillow Creek
Headwaters Willow Creek
Headwaters Ross Fork Creek
Upper Blake Creek
Upper Swimming Woman Creek
Minerva Creek
Upper Cameron Creek
Upper Pole Creek
Lower Blake Creek
Headwaters Careless Creek
Upper Twin Coulee
Upper Merrills Springs Creek
Walters Coulee
Headwaters Currant Creek
Timber Creek
N
0 2.5 5 10
Miles
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Snowies Geographic Area Boundary
Major Streams
Conservation Watershed Network
Big Spring Creek Municipal Watershed
Watershed Condition Class
Functioning Properly
Functioning at Risk
Impaired Function
Watershed Not Rated
Spring 2018

Lynx Analysis Units
Snowies Geographic Area

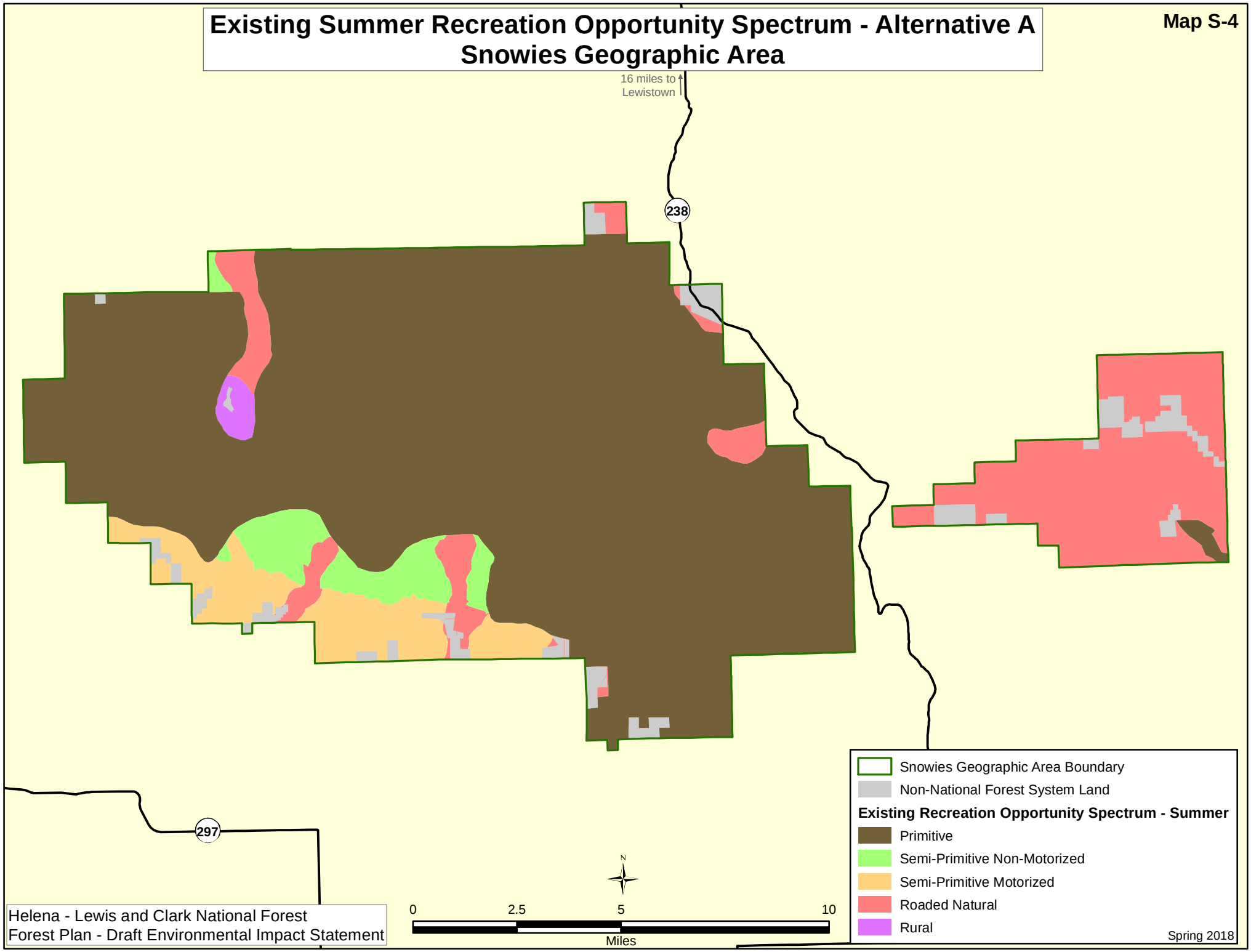
Map S-3



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Existing Summer Recreation Opportunity Spectrum - Alternative A
Snowies Geographic Area

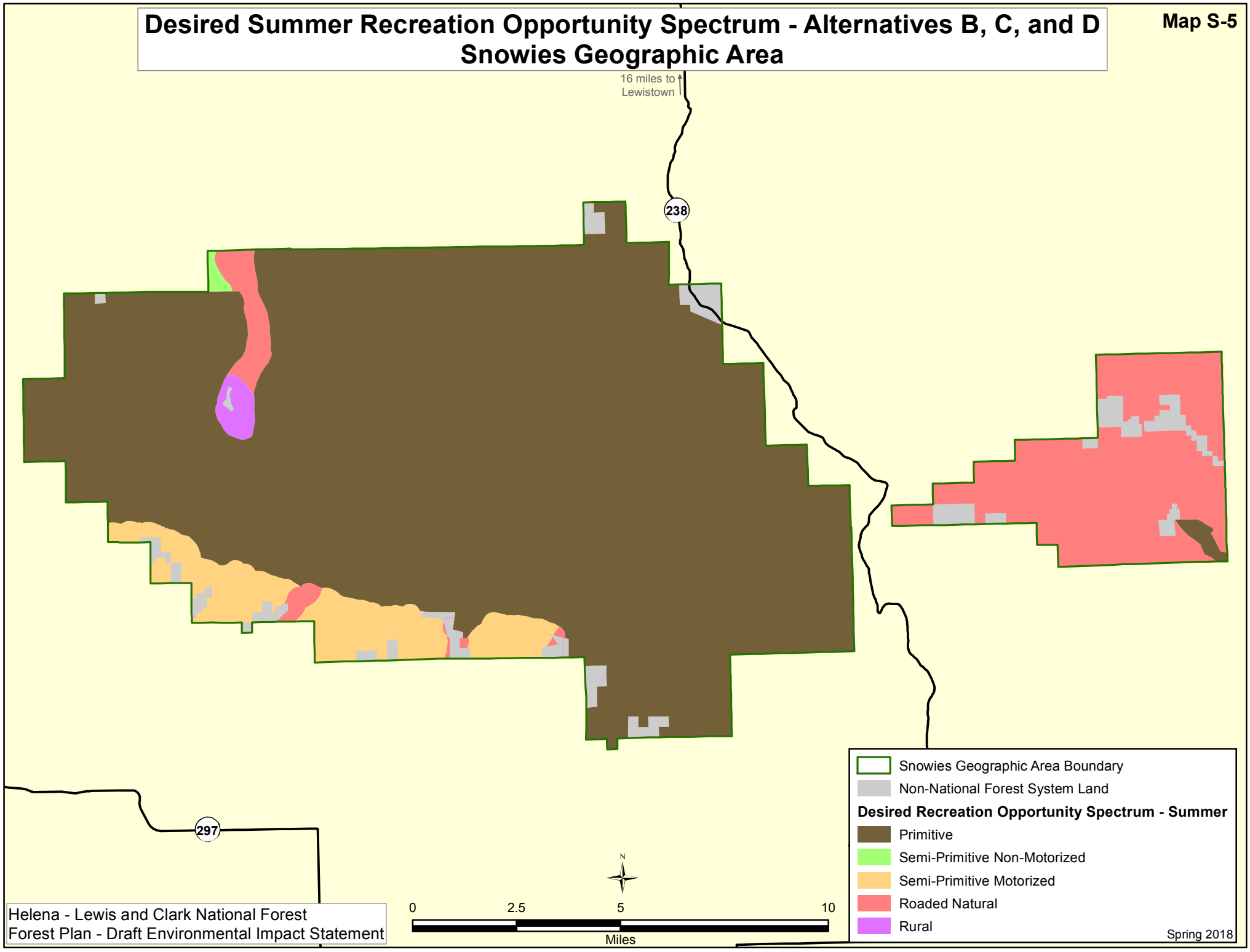
Map S-4



Helena - Lewis and Clark National Forest
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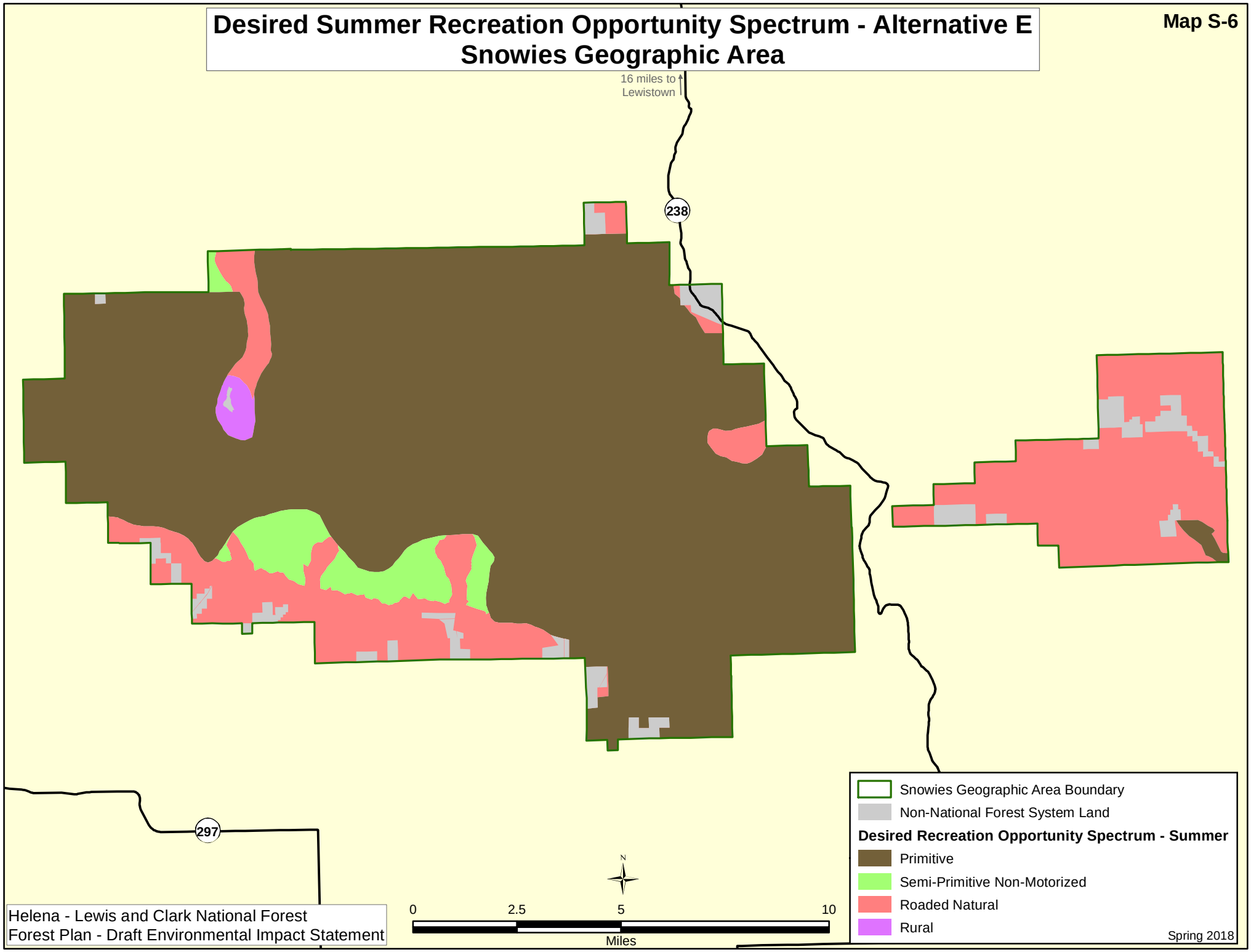
Desired Summer Recreation Opportunity Spectrum - Alternatives B, C, and D
Snowies Geographic Area

Map S-5



Desired Summer Recreation Opportunity Spectrum - Alternative E
Snowies Geographic Area

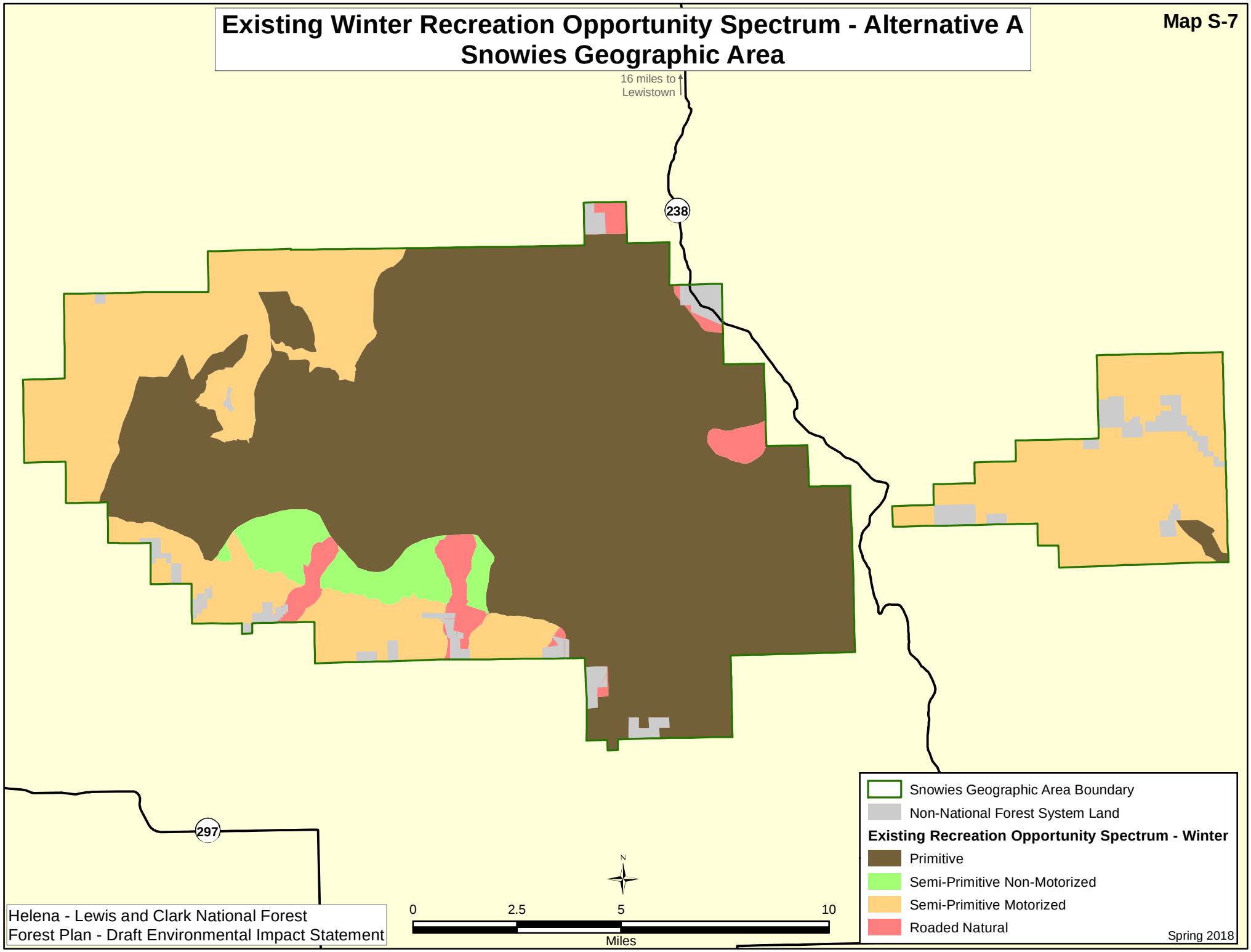
Map S-6



Helena - Lewis and Clark National Forest
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Existing Winter Recreation Opportunity Spectrum - Alternative A
Snowies Geographic Area

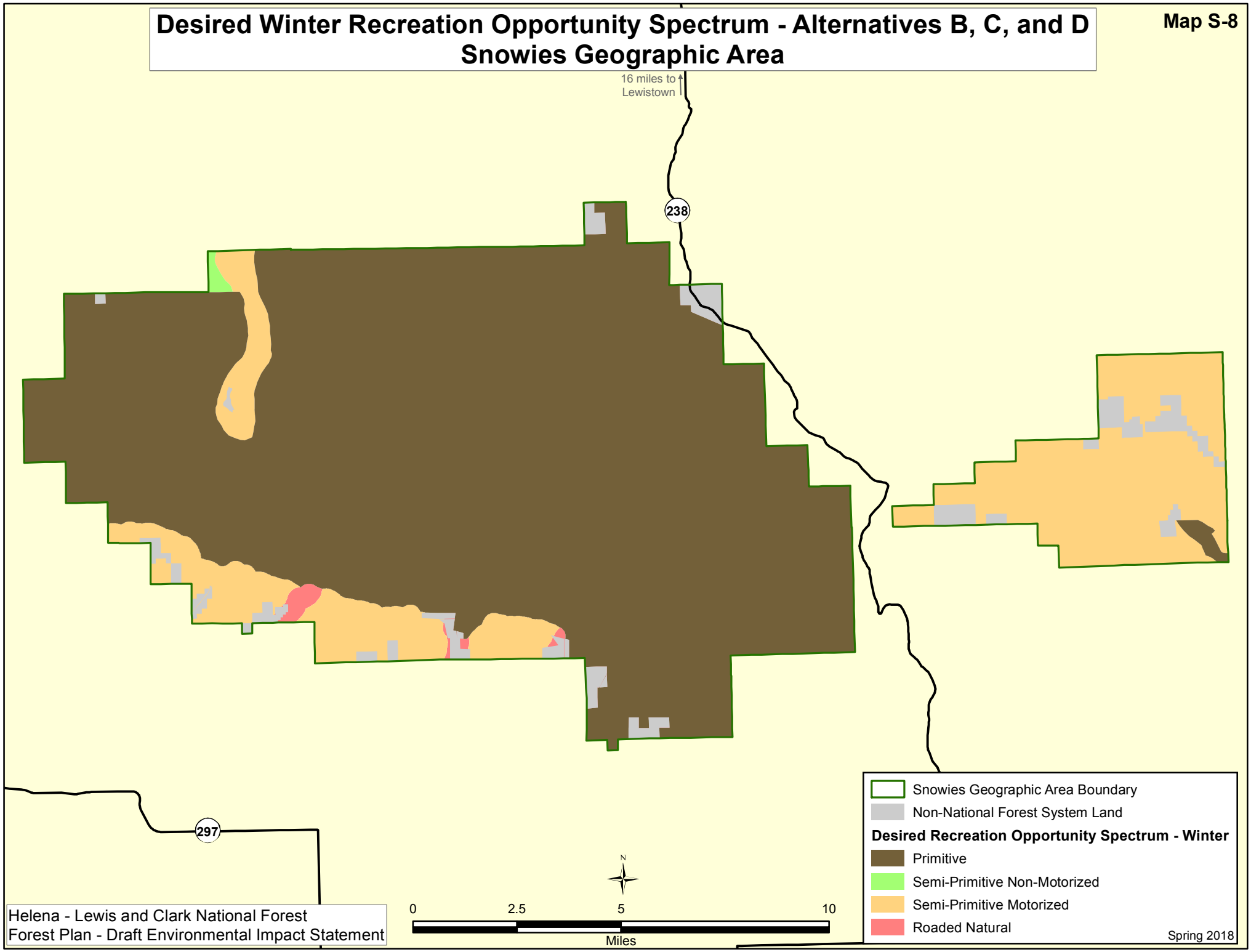
Map S-7



Helena - Lewis and Clark National Forest
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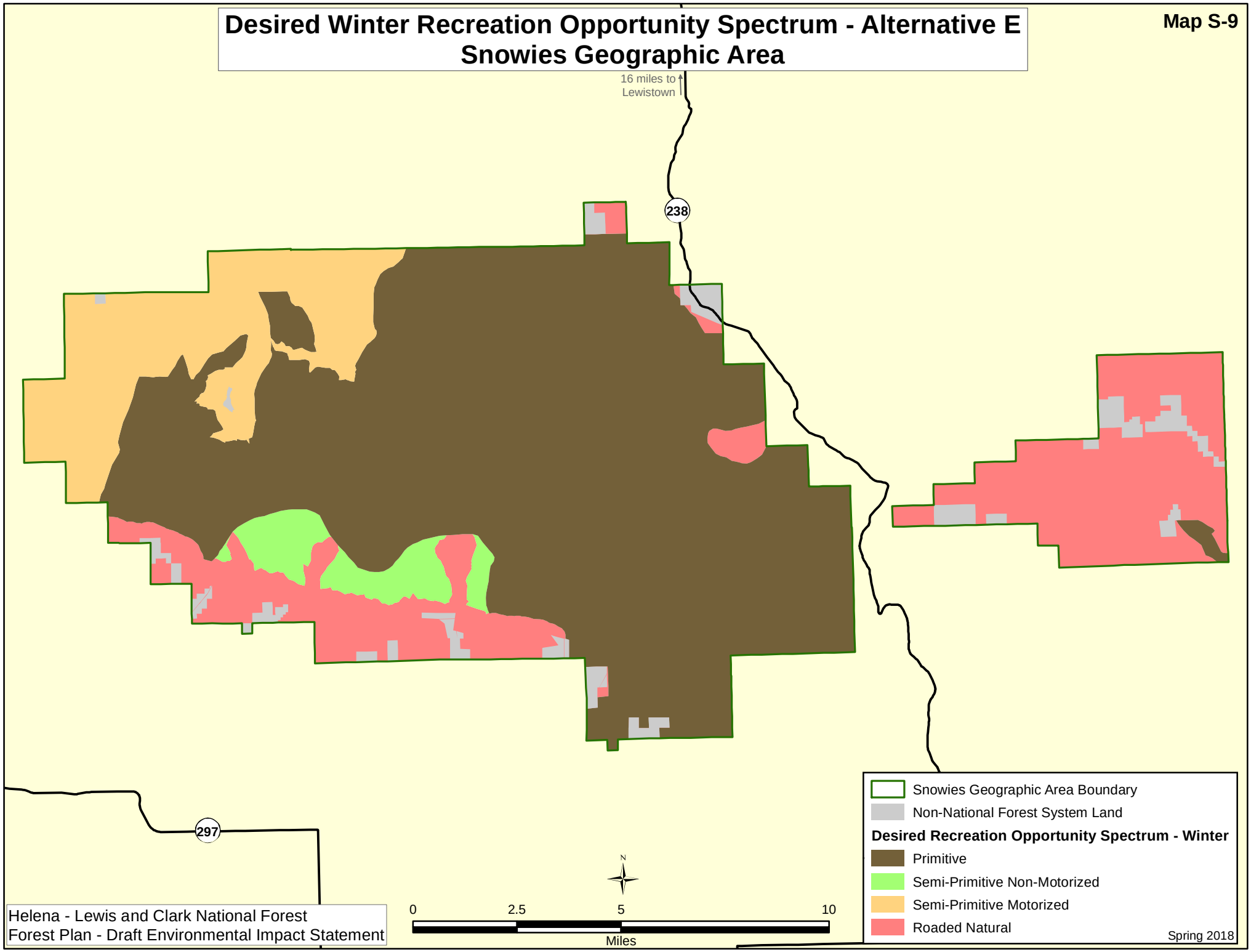
Desired Winter Recreation Opportunity Spectrum - Alternatives B, C, and D
Snowies Geographic Area

Map S-8



Desired Winter Recreation Opportunity Spectrum - Alternative E
Snowies Geographic Area

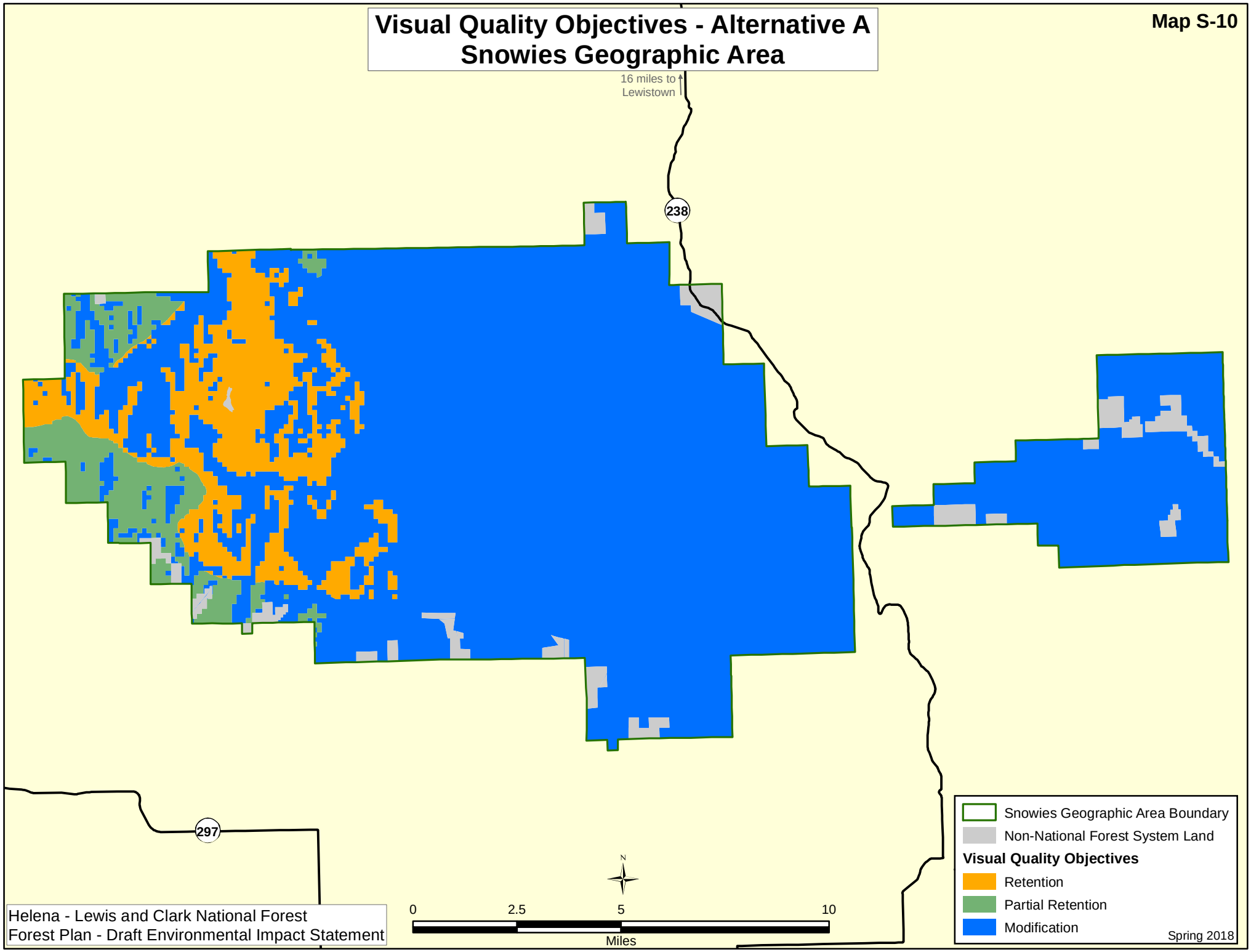
Map S-9



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Visual Quality Objectives - Alternative A
Snowies Geographic Area

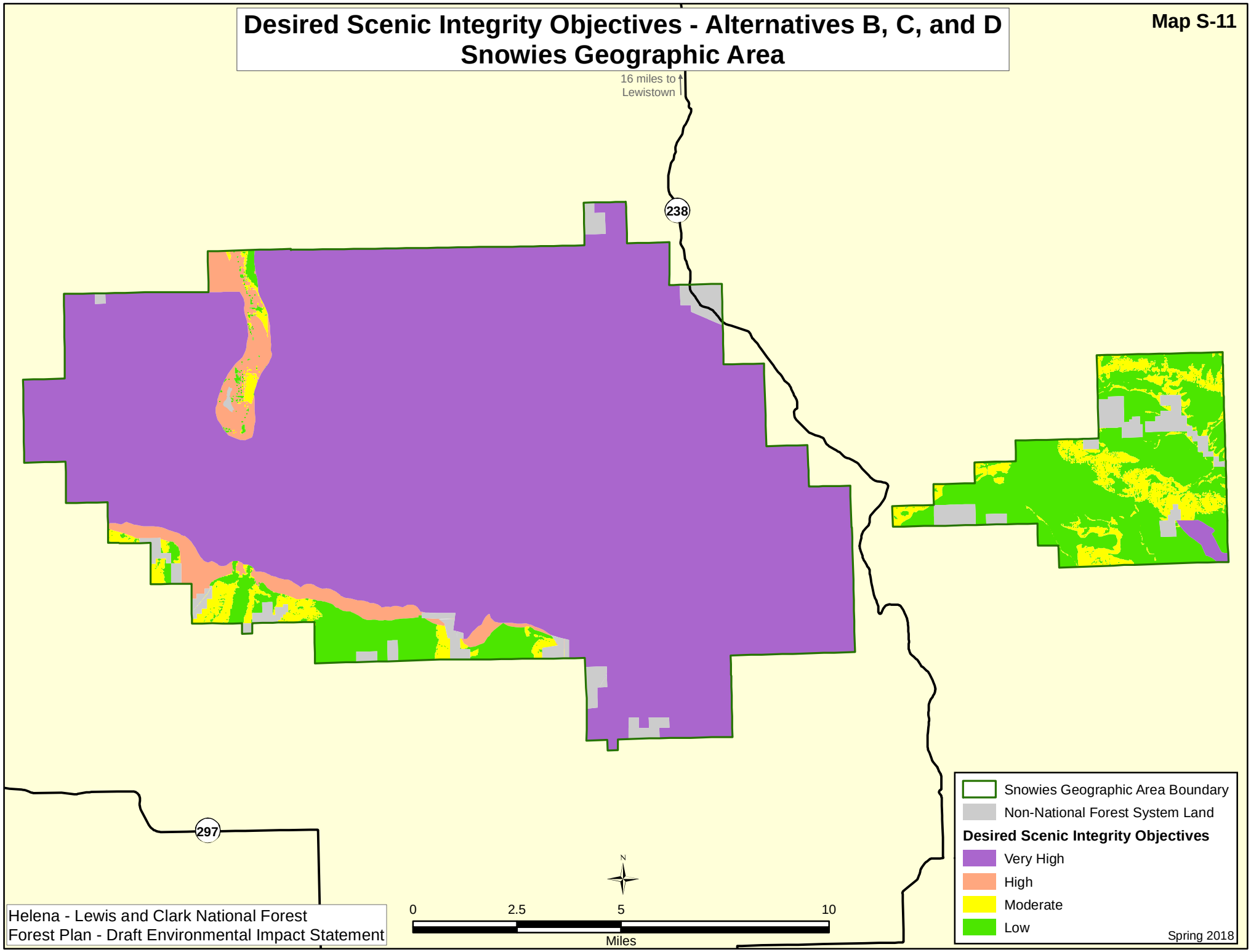
Map S-10



Helena - Lewis and Clark National Forest
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Desired Scenic Integrity Objectives - Alternatives B, C, and D
Snowies Geographic Area

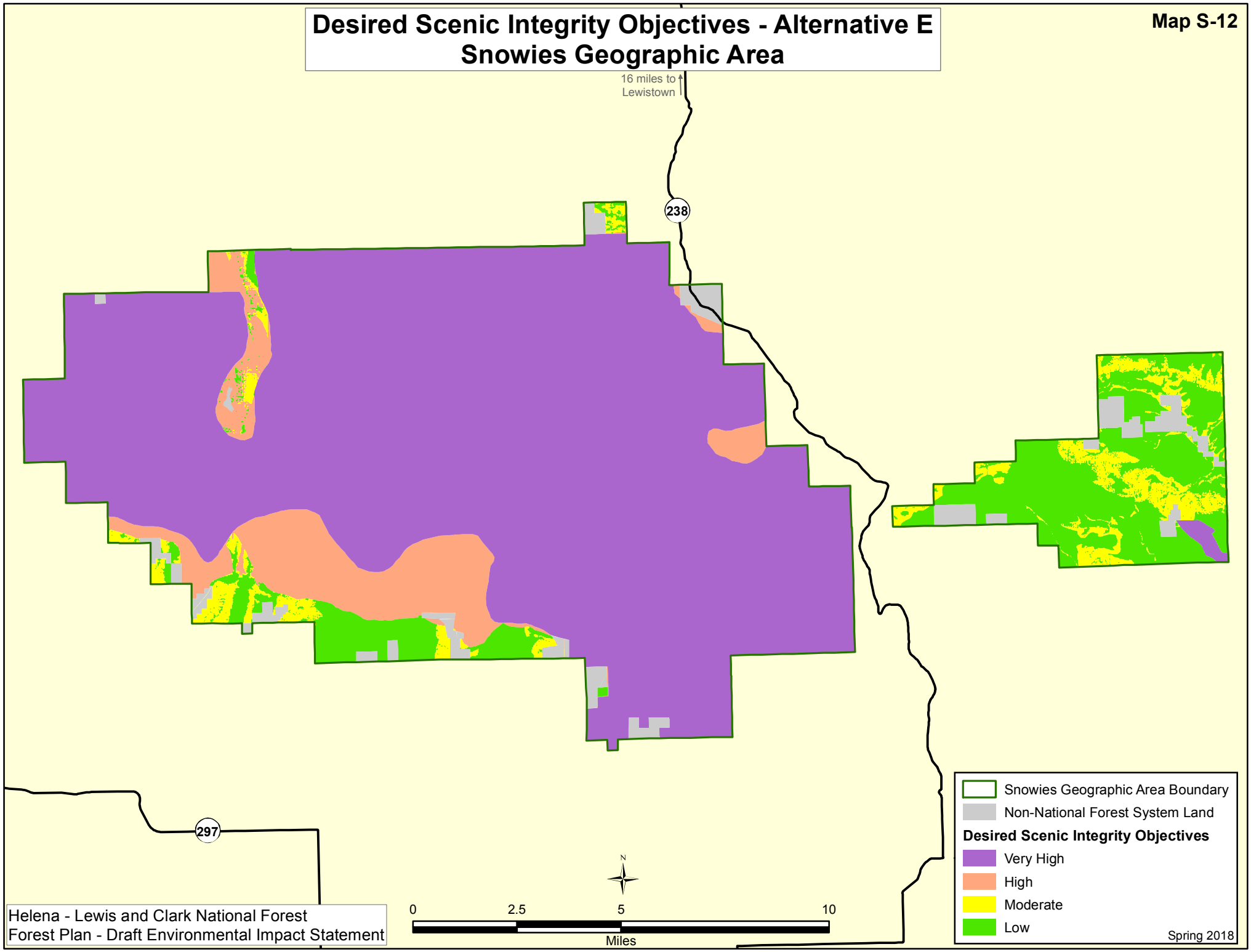
Map S-11



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Desired Scenic Integrity Objectives - Alternative E
Snowies Geographic Area

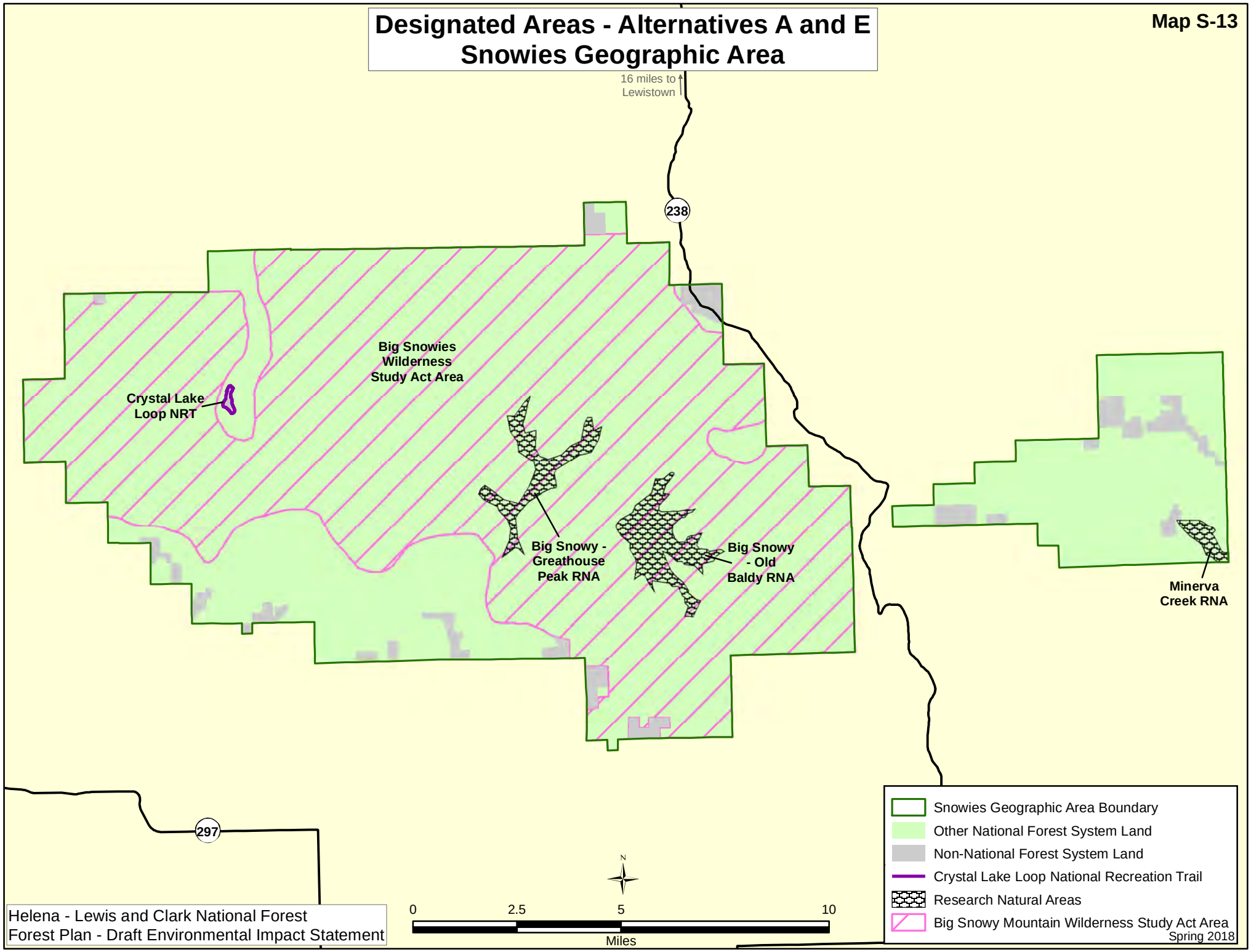
Map S-12



Helena - Lewis and Clark National Forest
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Designated Areas - Alternatives A and E
Snowies Geographic Area

Map S-13

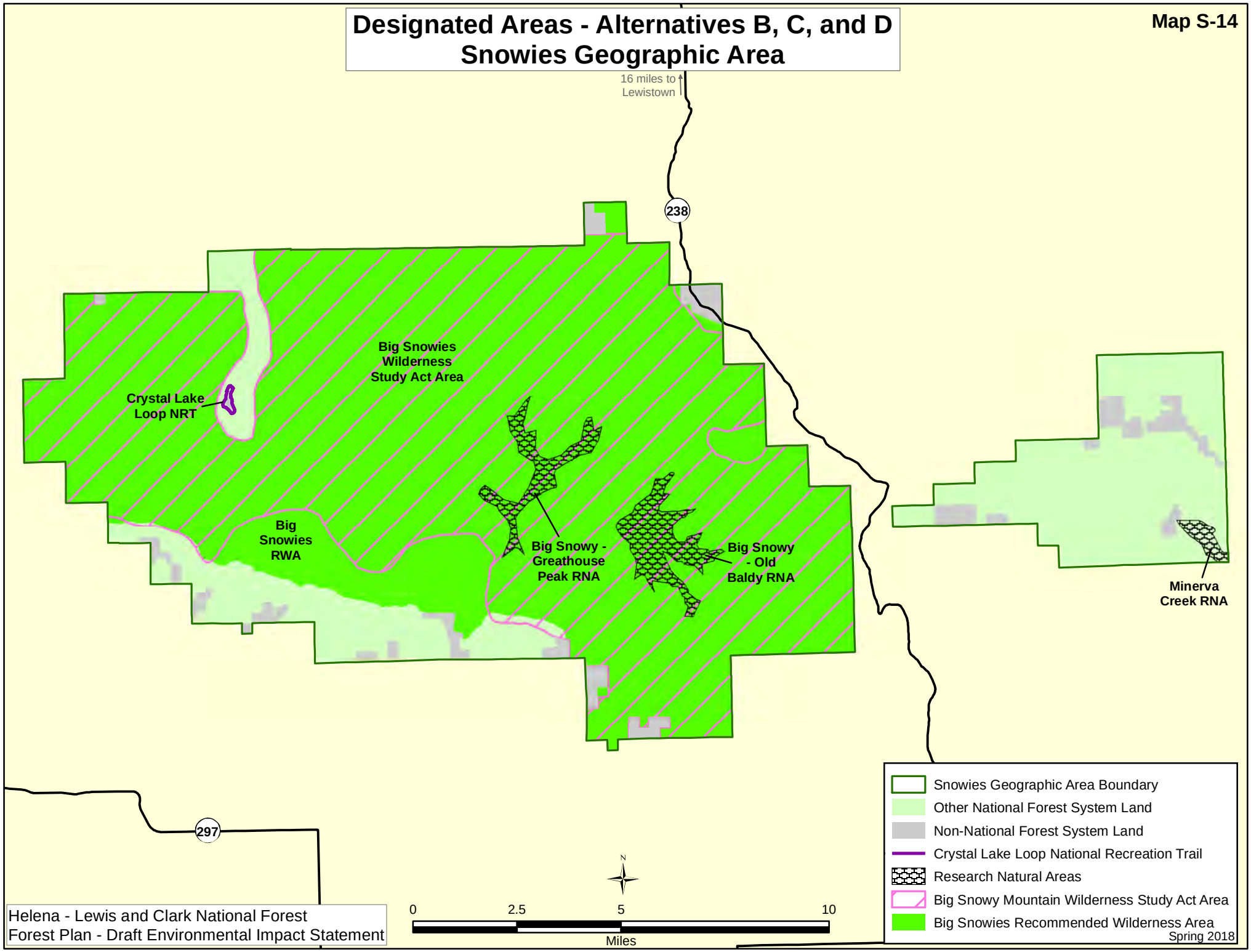


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Designated Areas - Alternatives B, C, and D
Snowies Geographic Area

Map S-14

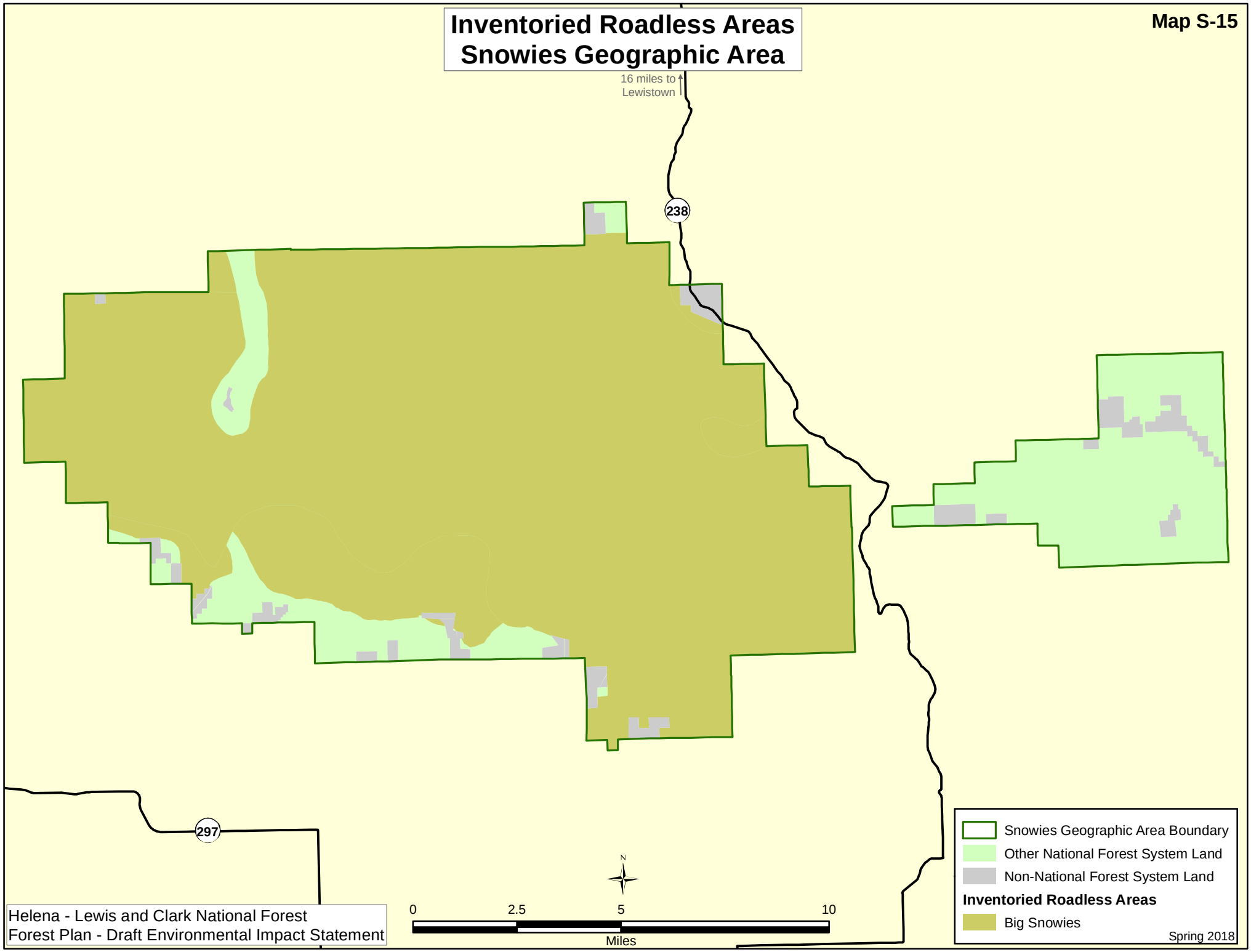


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Inventoried Roadless Areas
Snowies Geographic Area

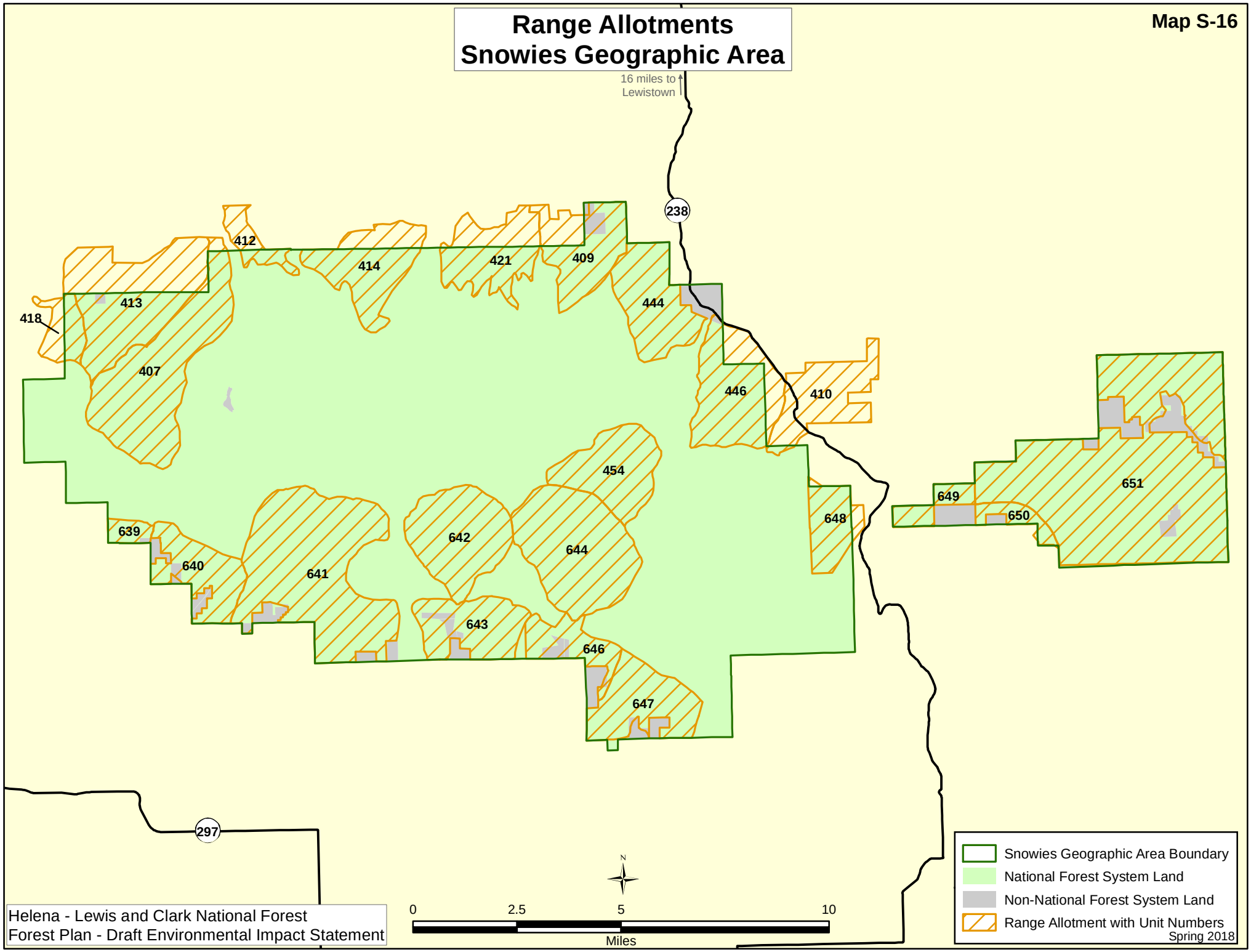
Map S-15



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Range Allotments
Snowies Geographic Area

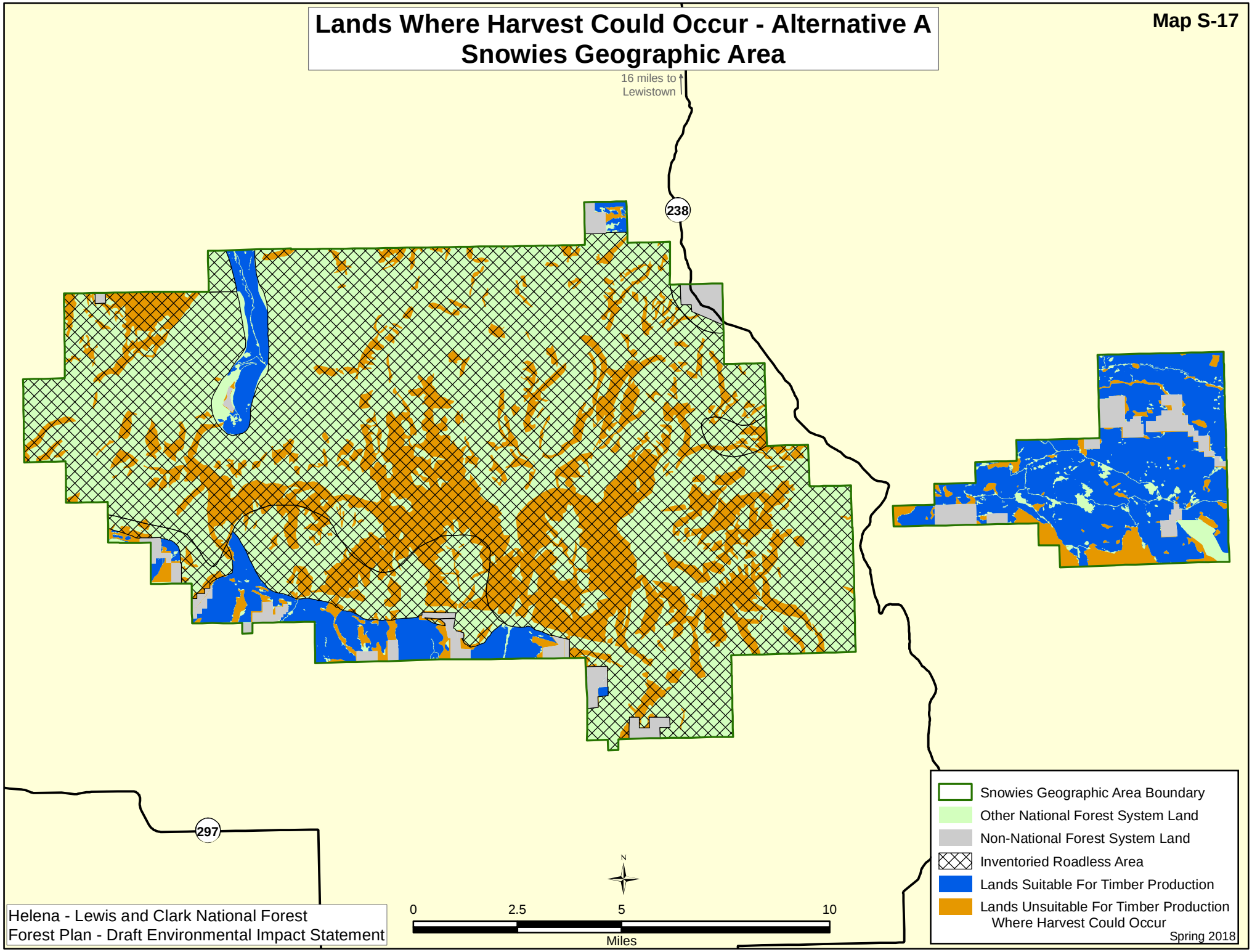
Map S-16



Helena - Lewis and Clark National Forest
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Lands Where Harvest Could Occur - Alternative A
Snowies Geographic Area

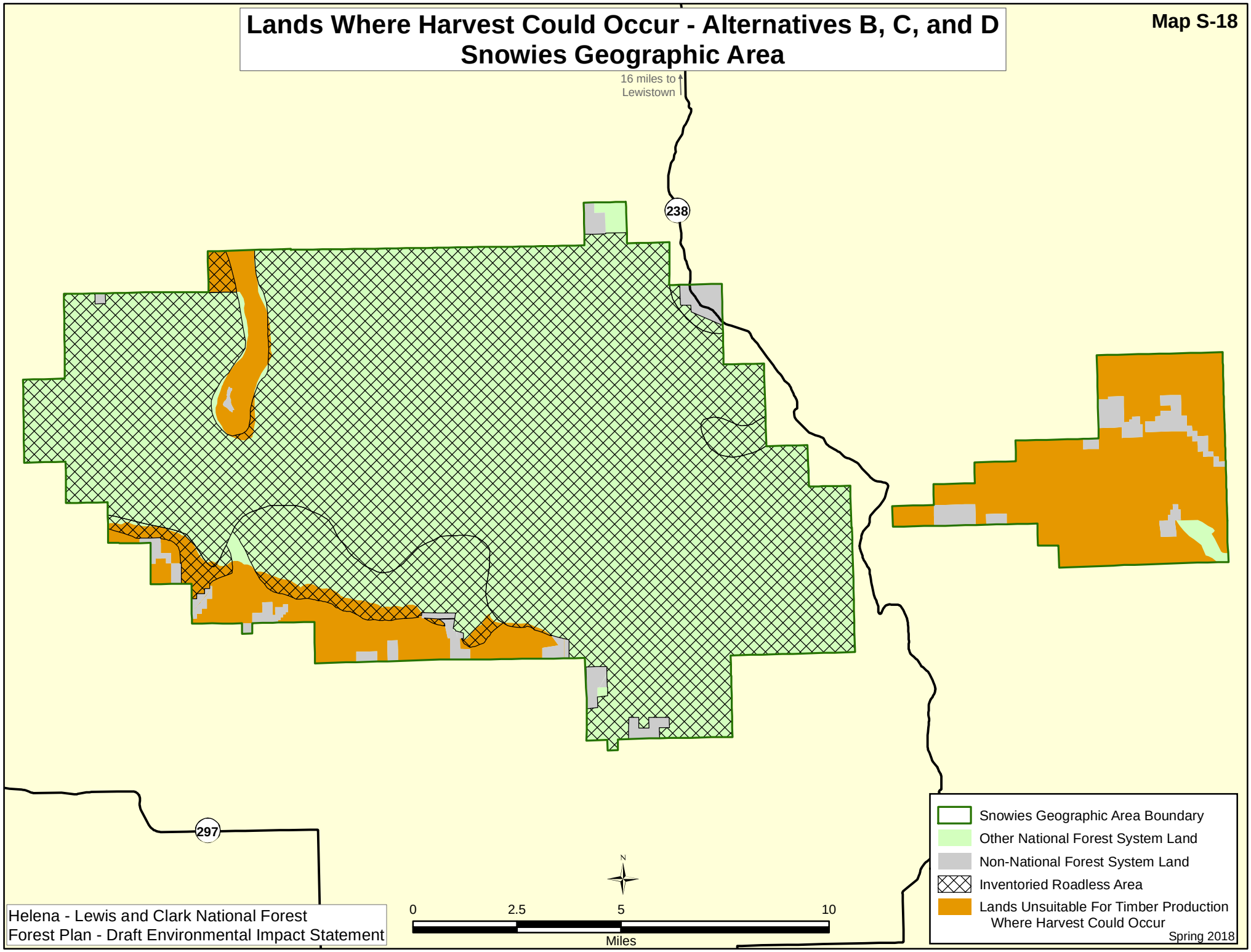
Map S-17



Helena - Lewis and Clark National Forest
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Lands Where Harvest Could Occur - Alternatives B, C, and D
Snowies Geographic Area

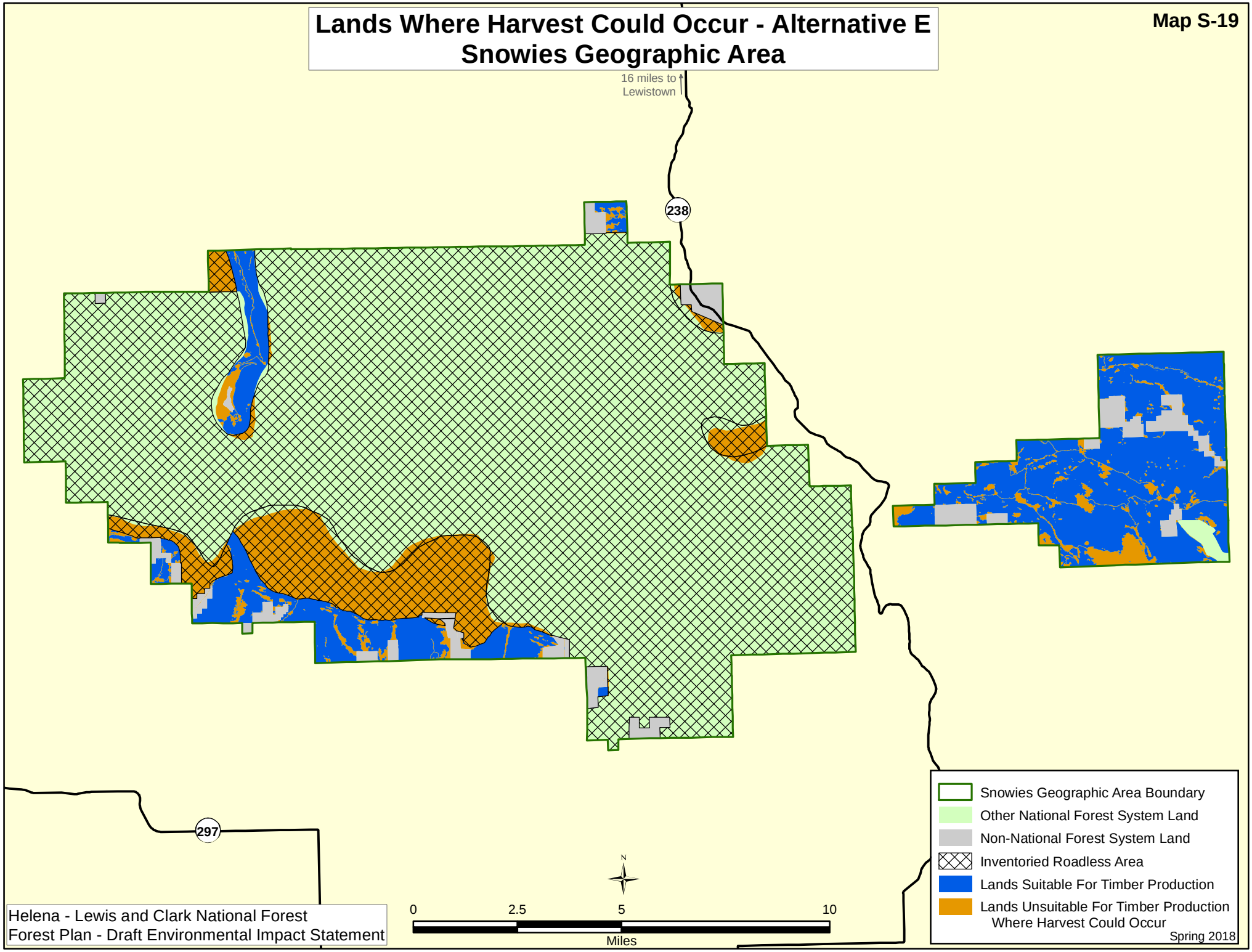
Map S-18



Helena - Lewis and Clark National Forest
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Lands Where Harvest Could Occur - Alternative E
Snowies Geographic Area

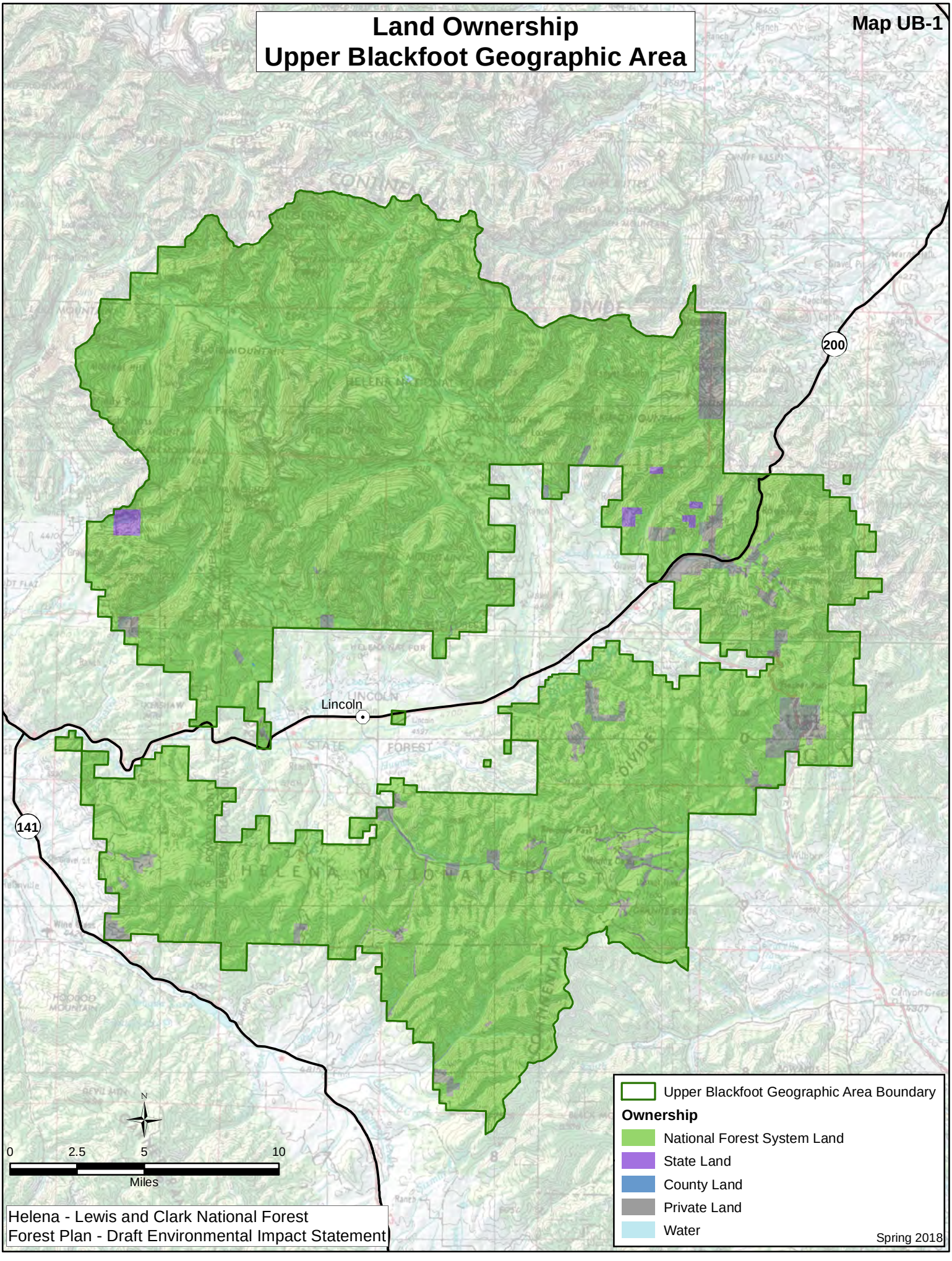
Map S-19



Helena - Lewis and Clark National Forest
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Land Ownership
Upper Blackfoot Geographic Area

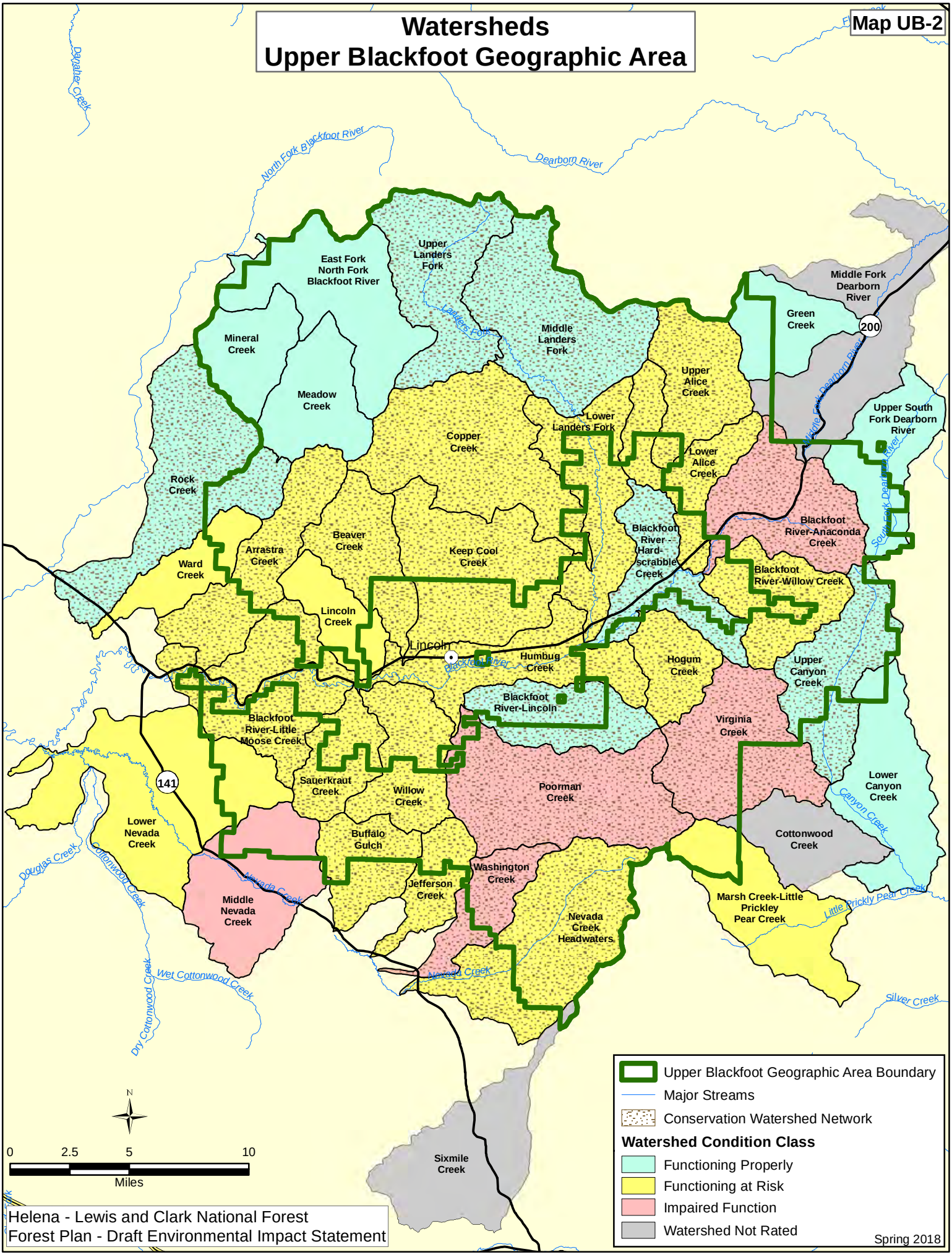
Map UB-1



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Watersheds
Upper Blackfoot Geographic Area

Map UB-2

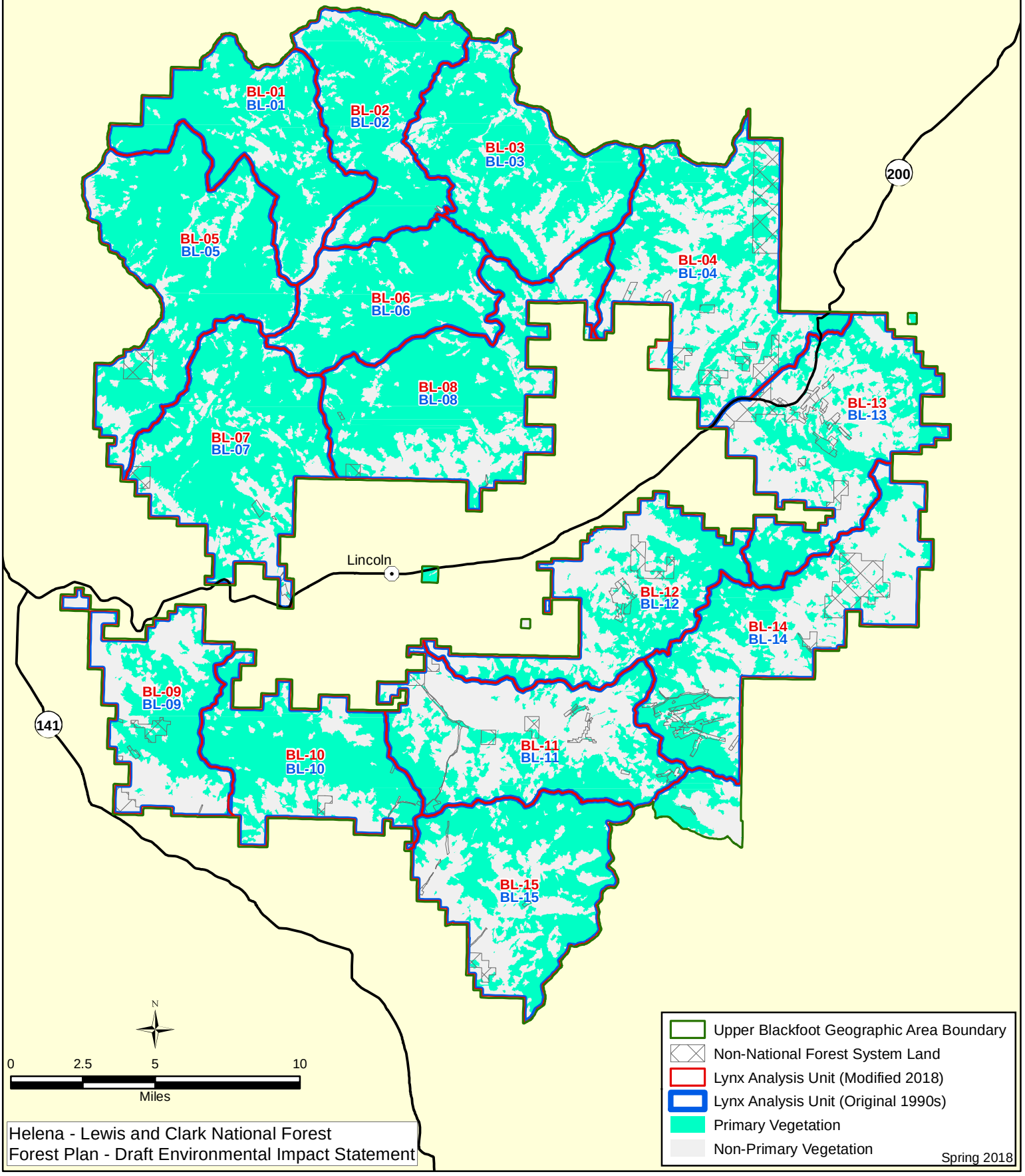


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Lynx Analysis Units
Upper Blackfoot Geographic Area

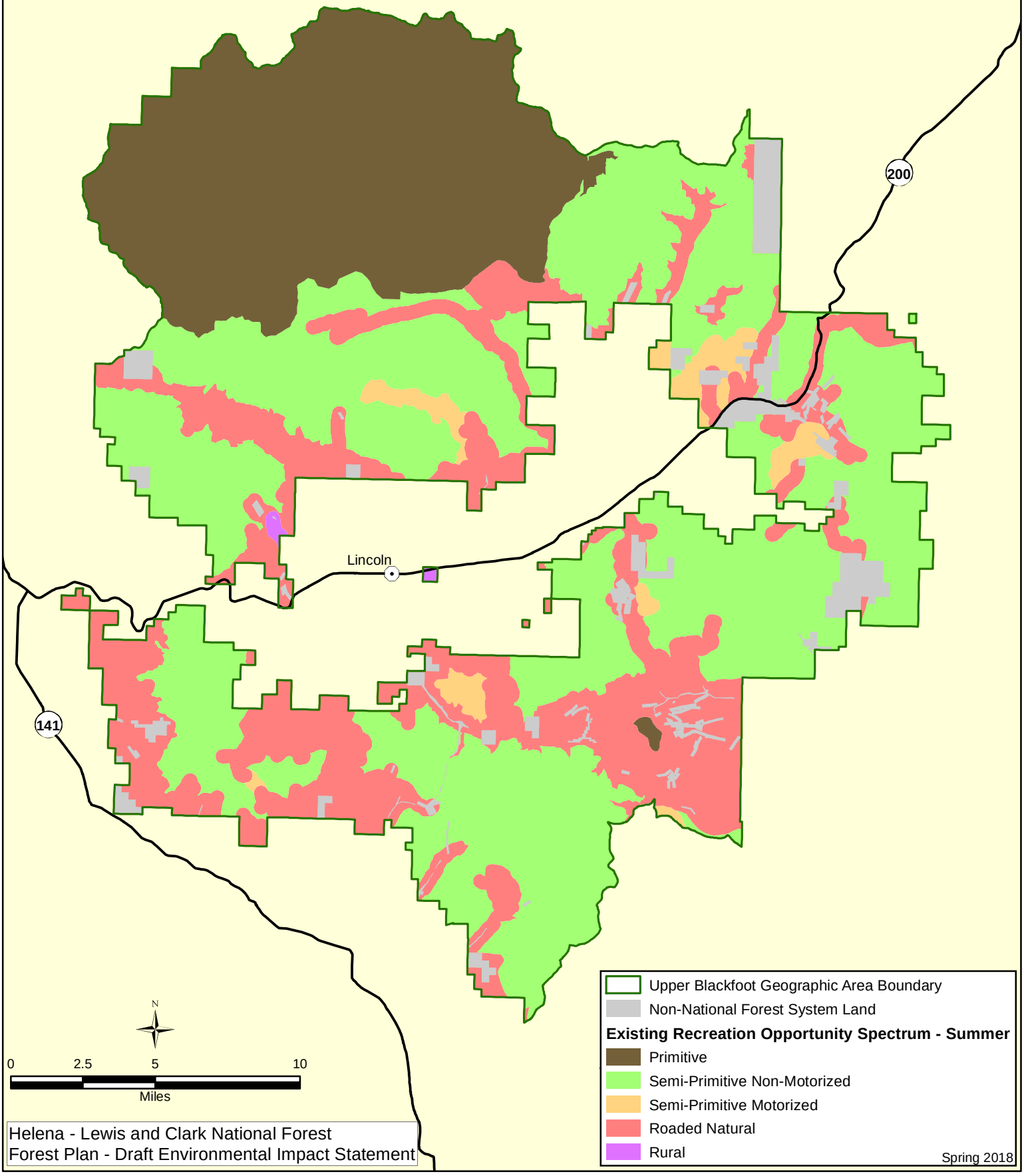
Map UB-3



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Existing Summer Recreation Opportunity Spectrum - Alternative A
Upper Blackfoot Geographic Area

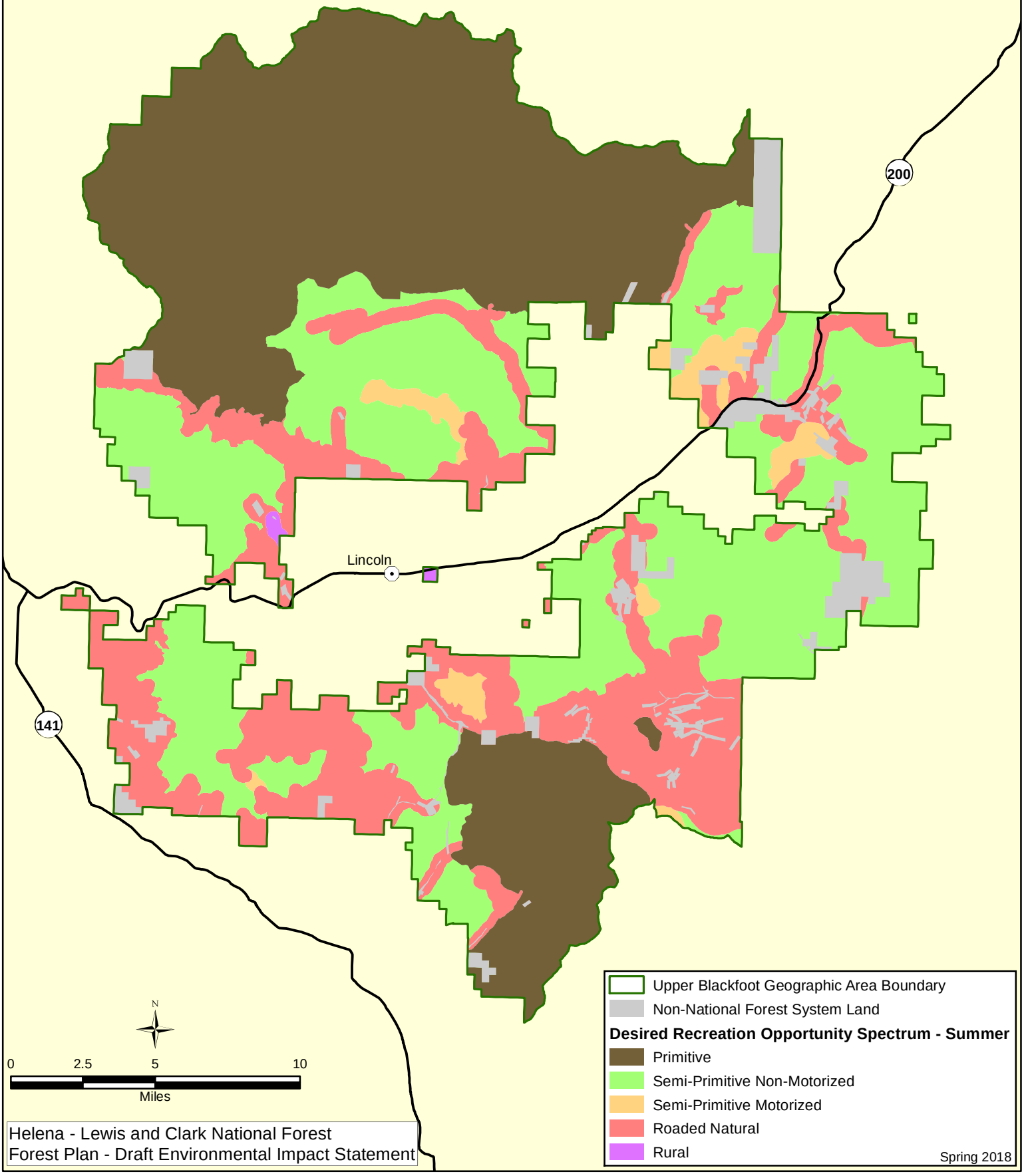
Map UB-4



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Desired Summer Recreation Opportunity Spectrum - Alternatives B, C, & D
Upper Blackfoot Geographic Area

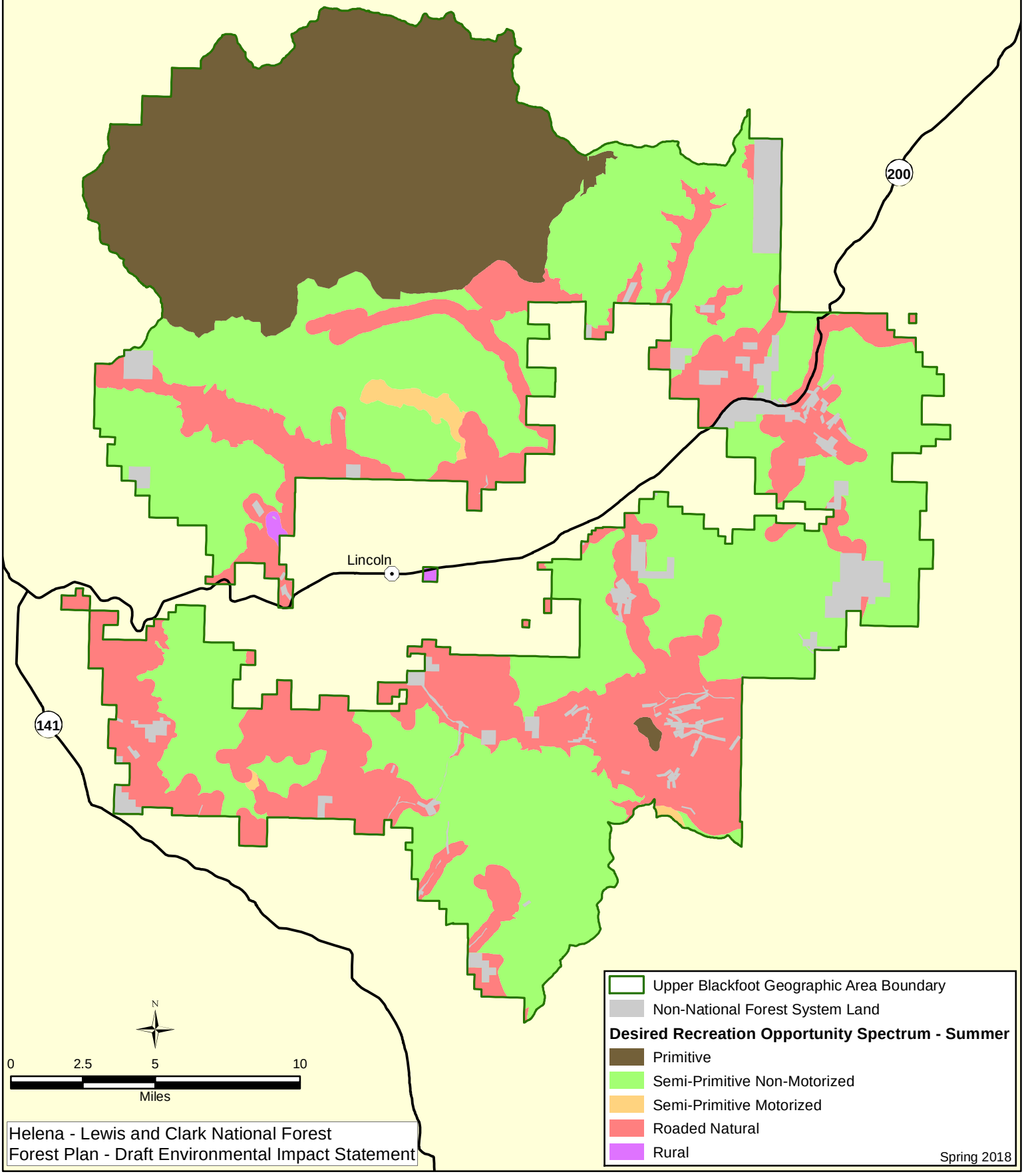
Map UB-5



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Desired Summer Recreation Opportunity Spectrum - Alternative E
Upper Blackfoot Geographic Area

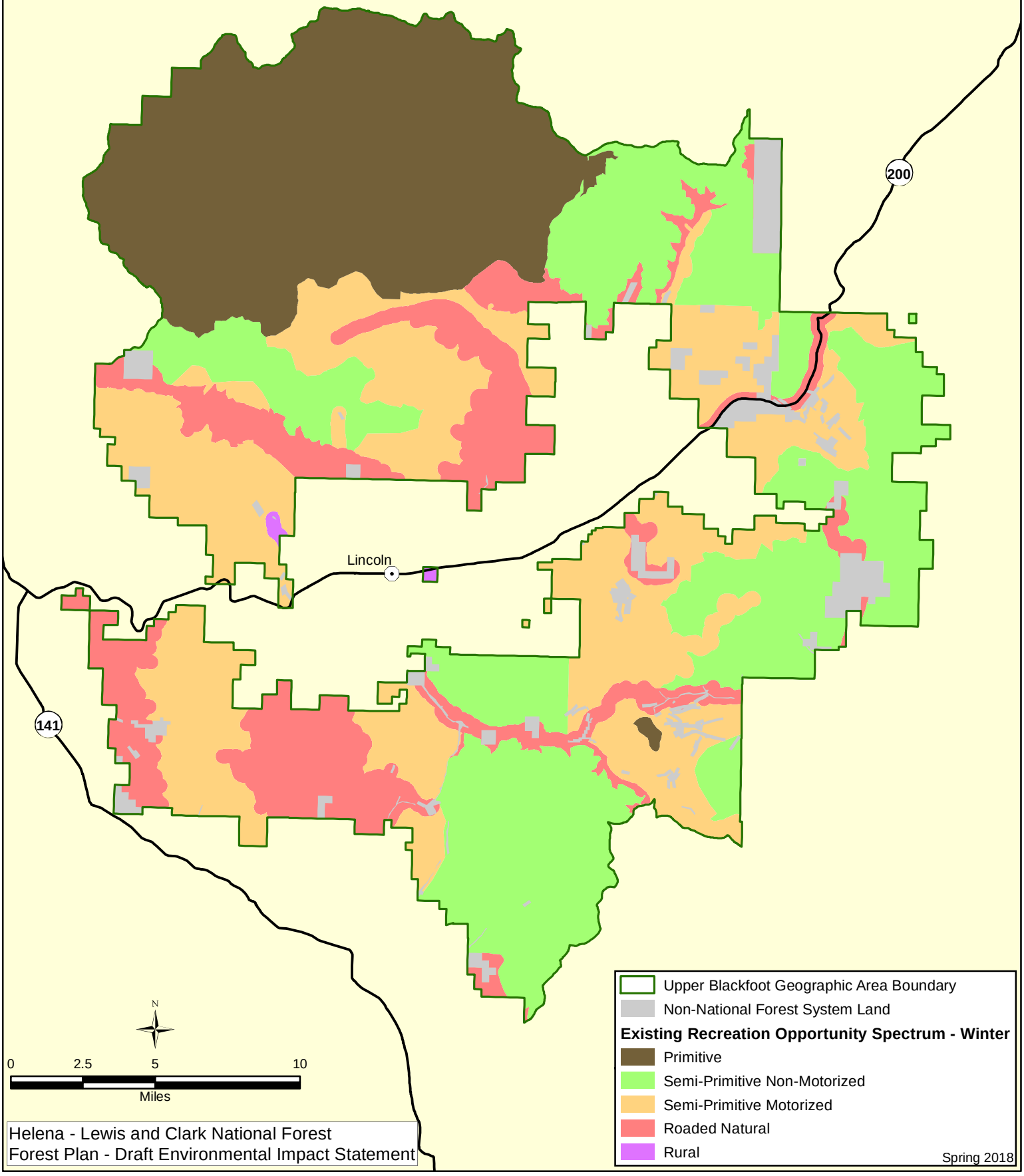
Map UB-6



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Existing Winter Recreation Opportunity Spectrum - Alternative A
Upper Blackfoot Geographic Area

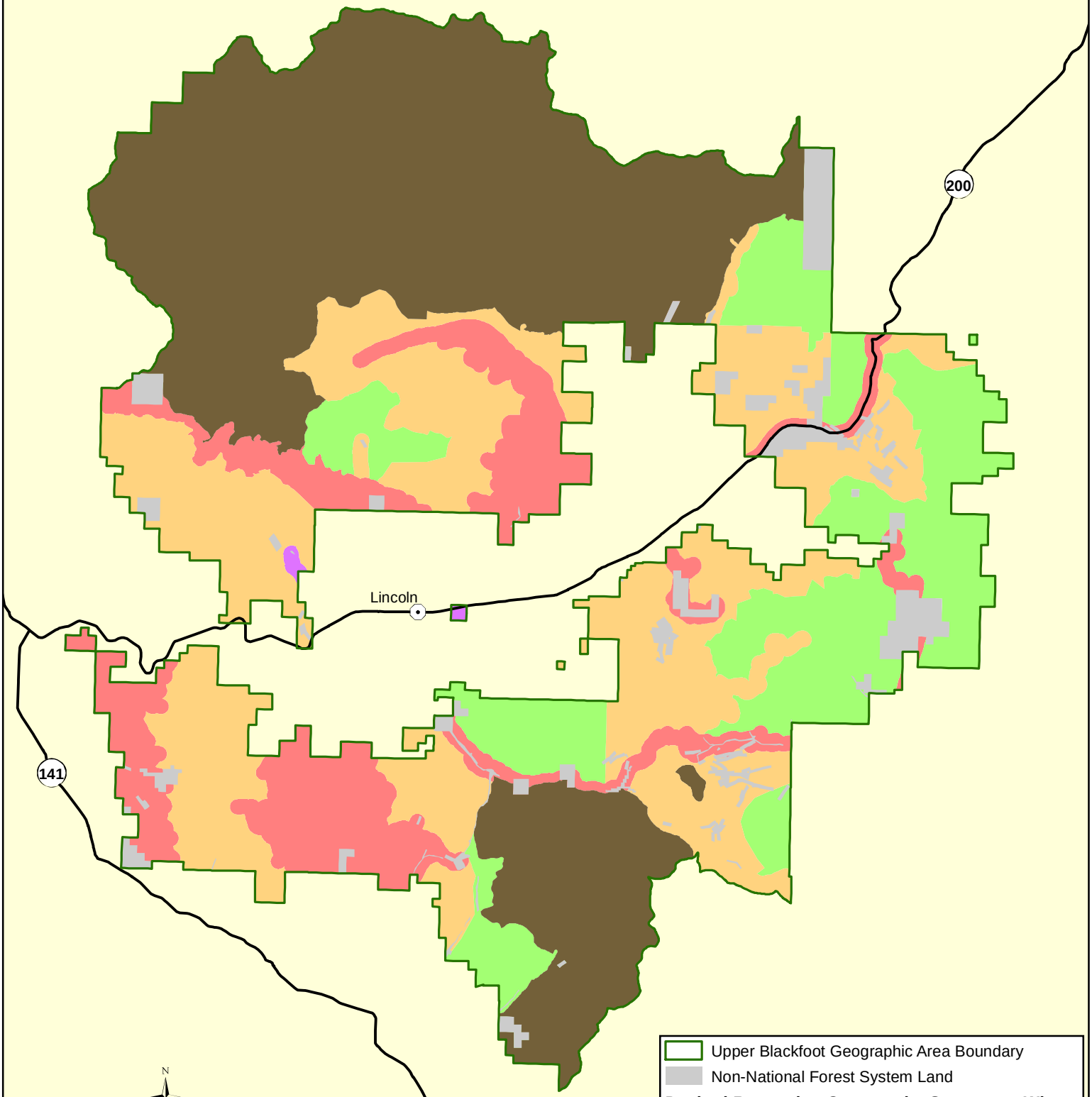
Map UB-7



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Desired Winter Recreation Opportunity Spectrum - Alternatives B, C, & D
Upper Blackfoot Geographic Area

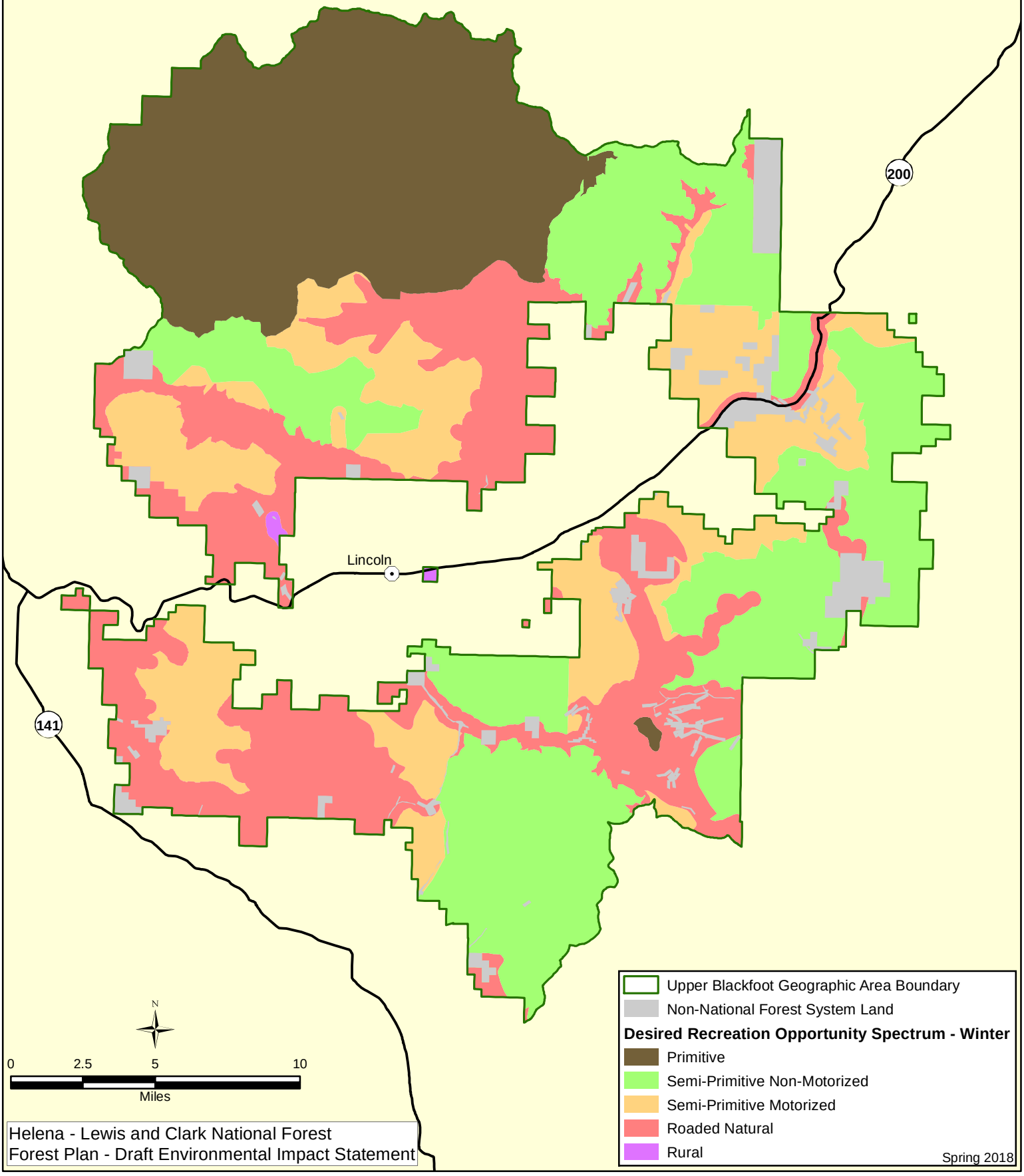
Map UB-8



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Desired Winter Recreation Opportunity Spectrum - Alternative E
Upper Blackfoot Geographic Area

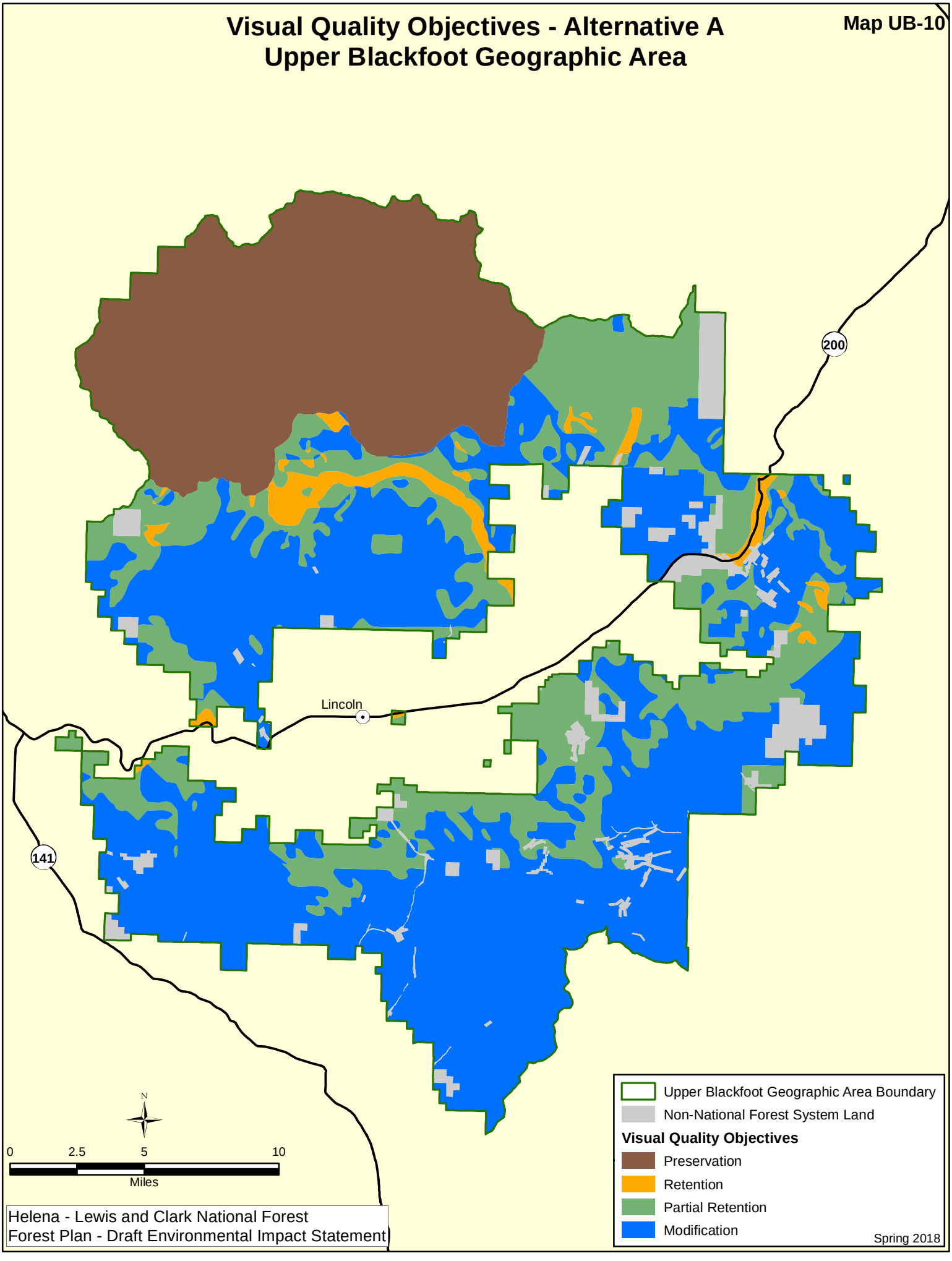
Map UB-9



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Visual Quality Objectives - Alternative A
Upper Blackfoot Geographic Area

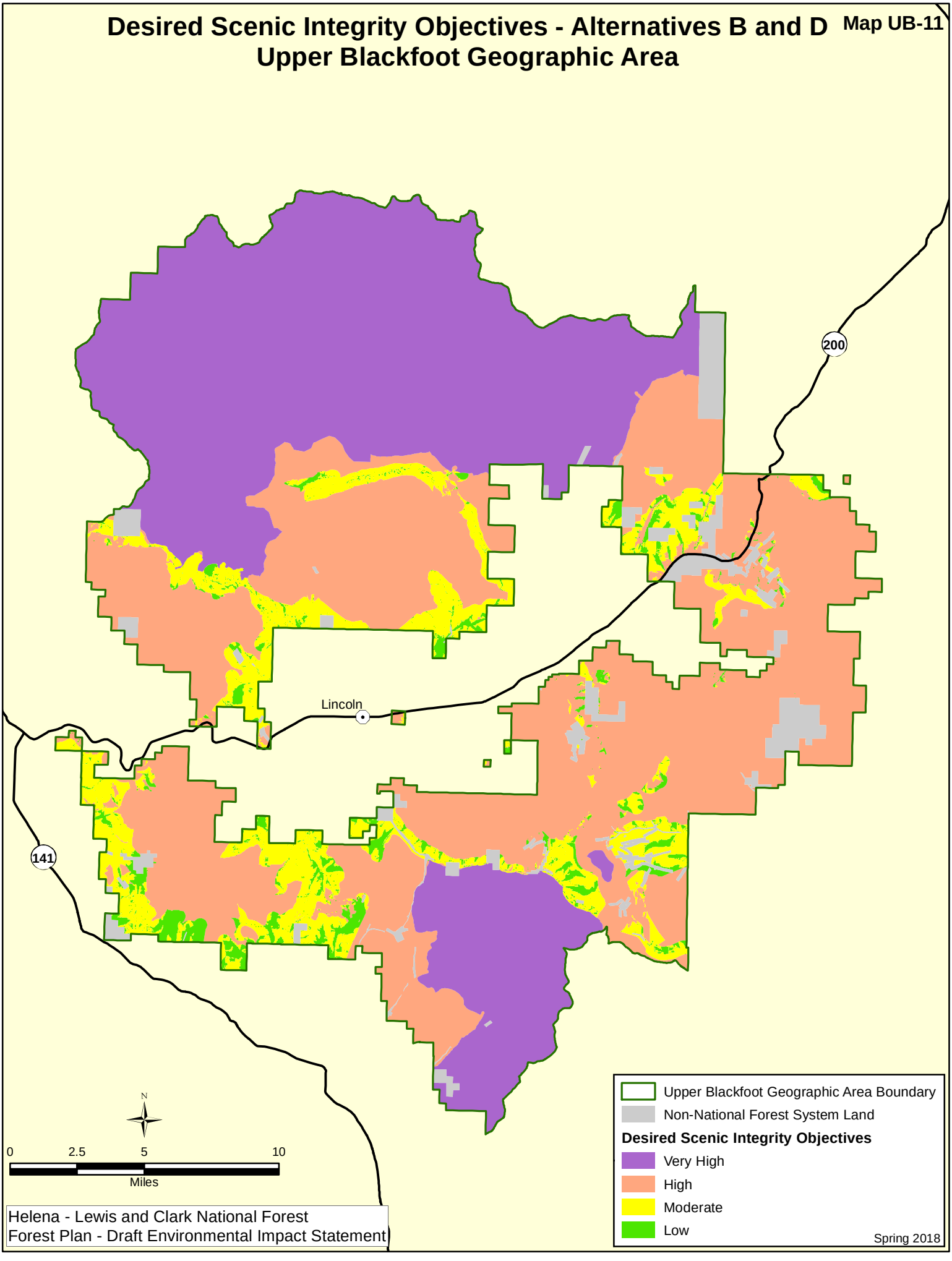
Map UB-10



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Desired Scenic Integrity Objectives - Alternatives B and D
Upper Blackfoot Geographic Area

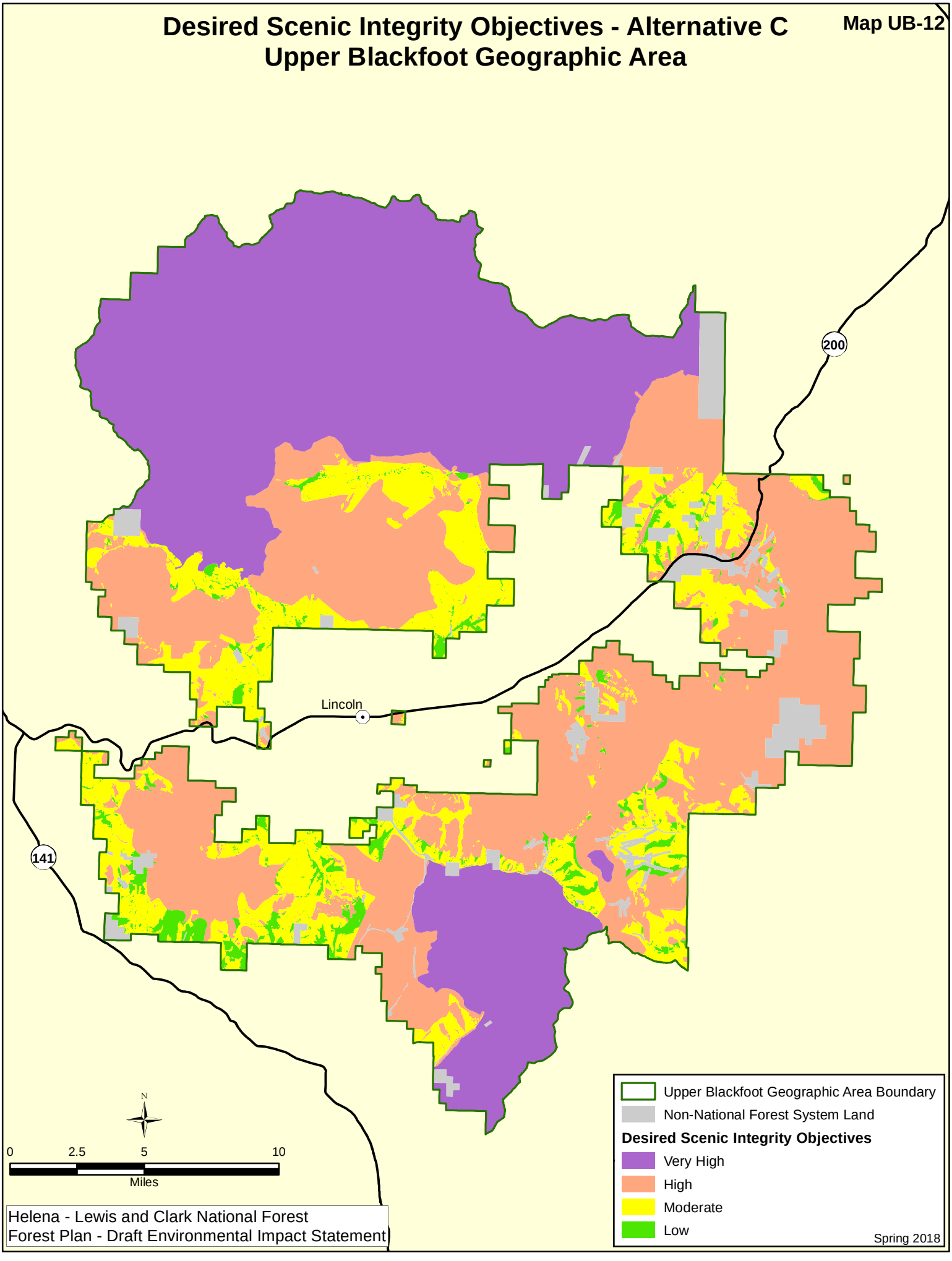
Map UB-11



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Desired Scenic Integrity Objectives - Alternative C
Upper Blackfoot Geographic Area

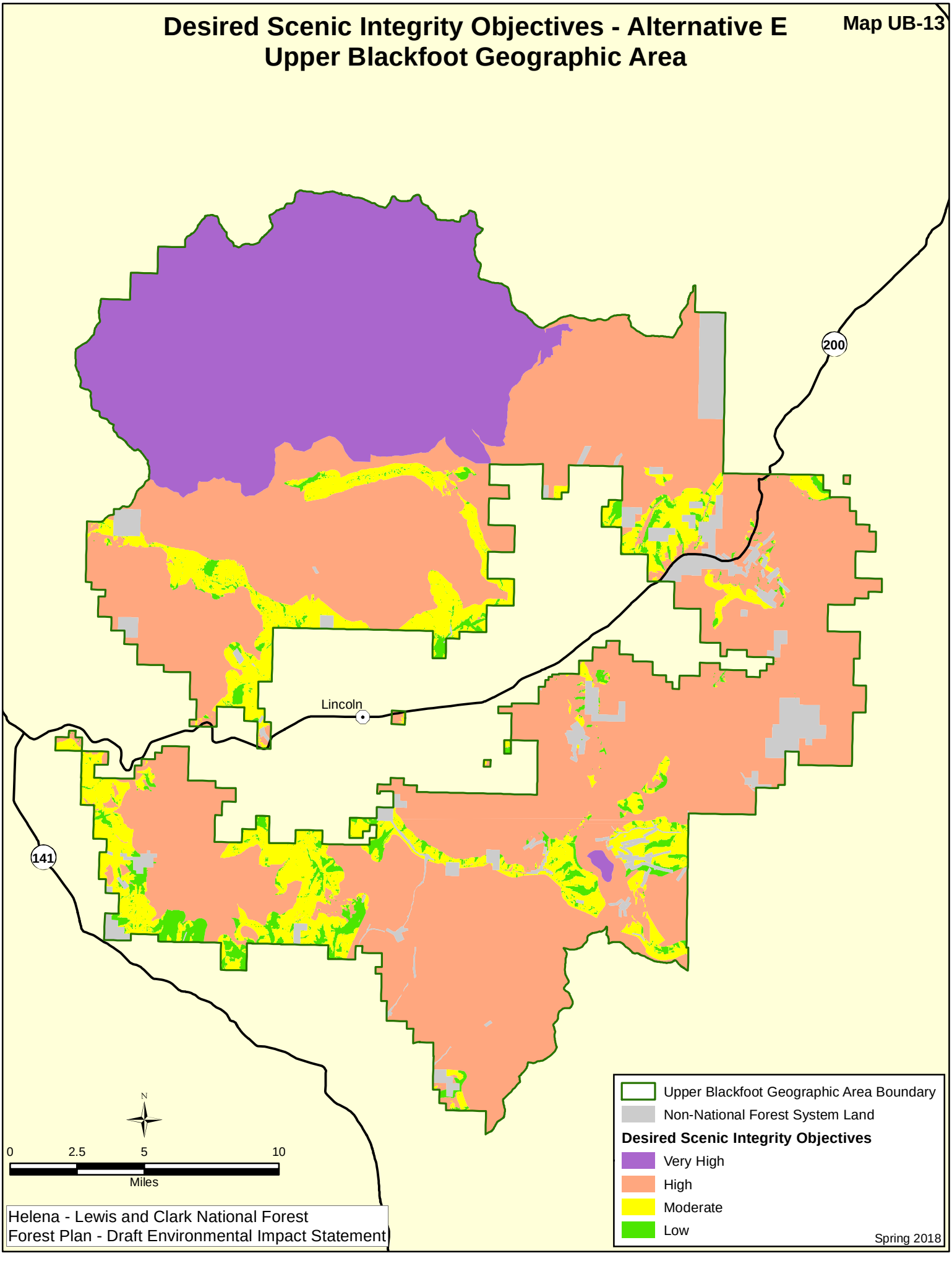
Map UB-12



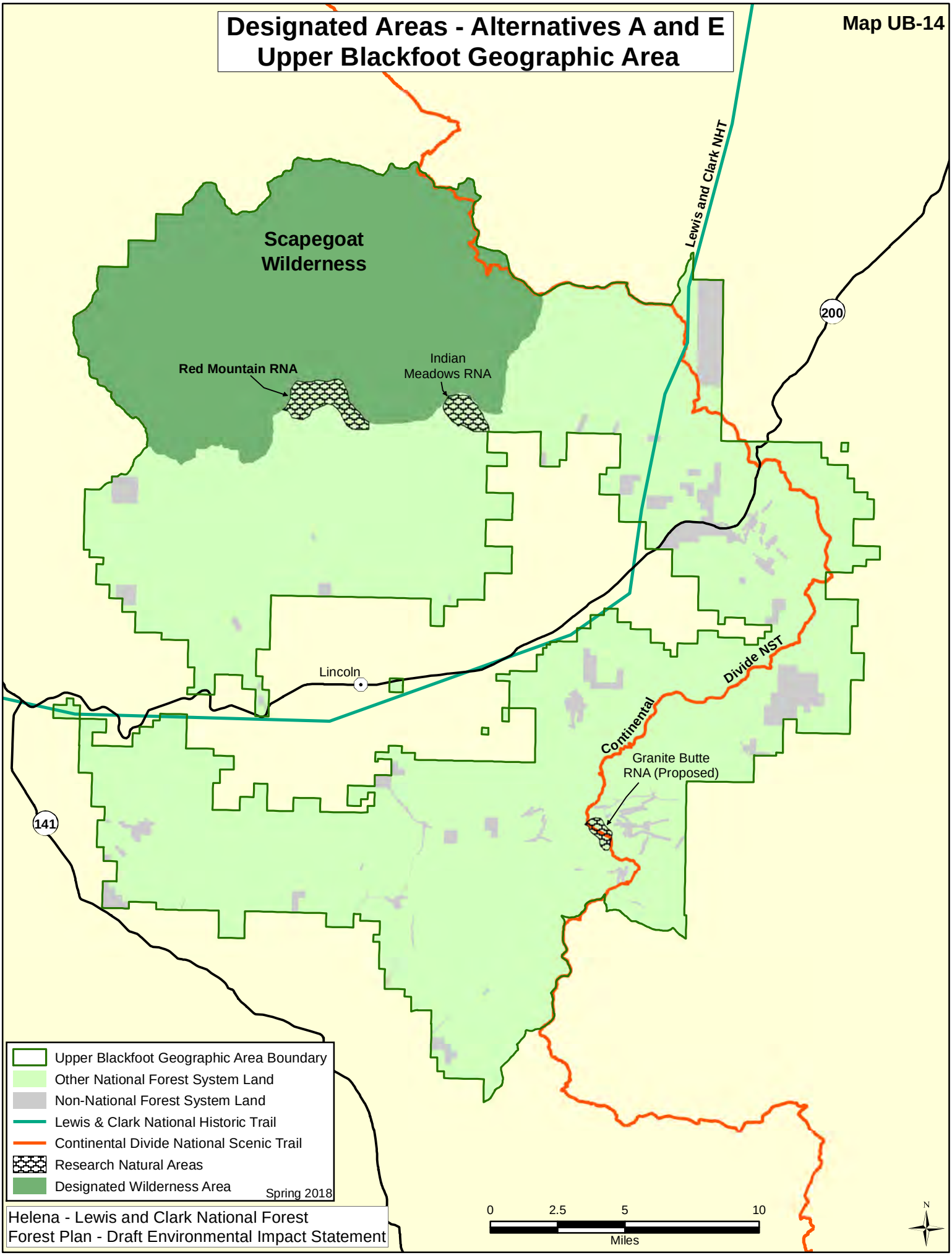
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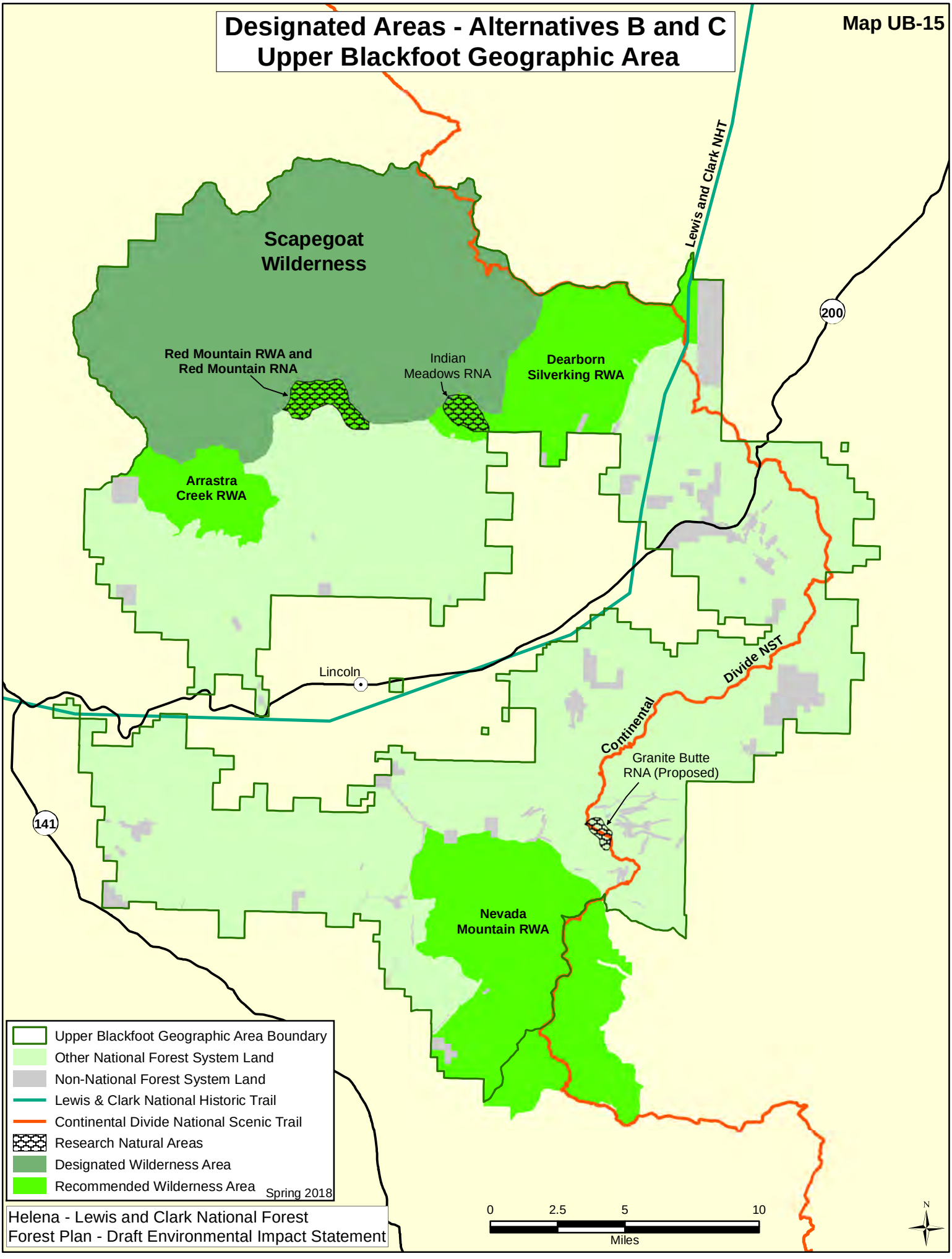
Desired Scenic Integrity Objectives - Alternative E
Upper Blackfoot Geographic Area

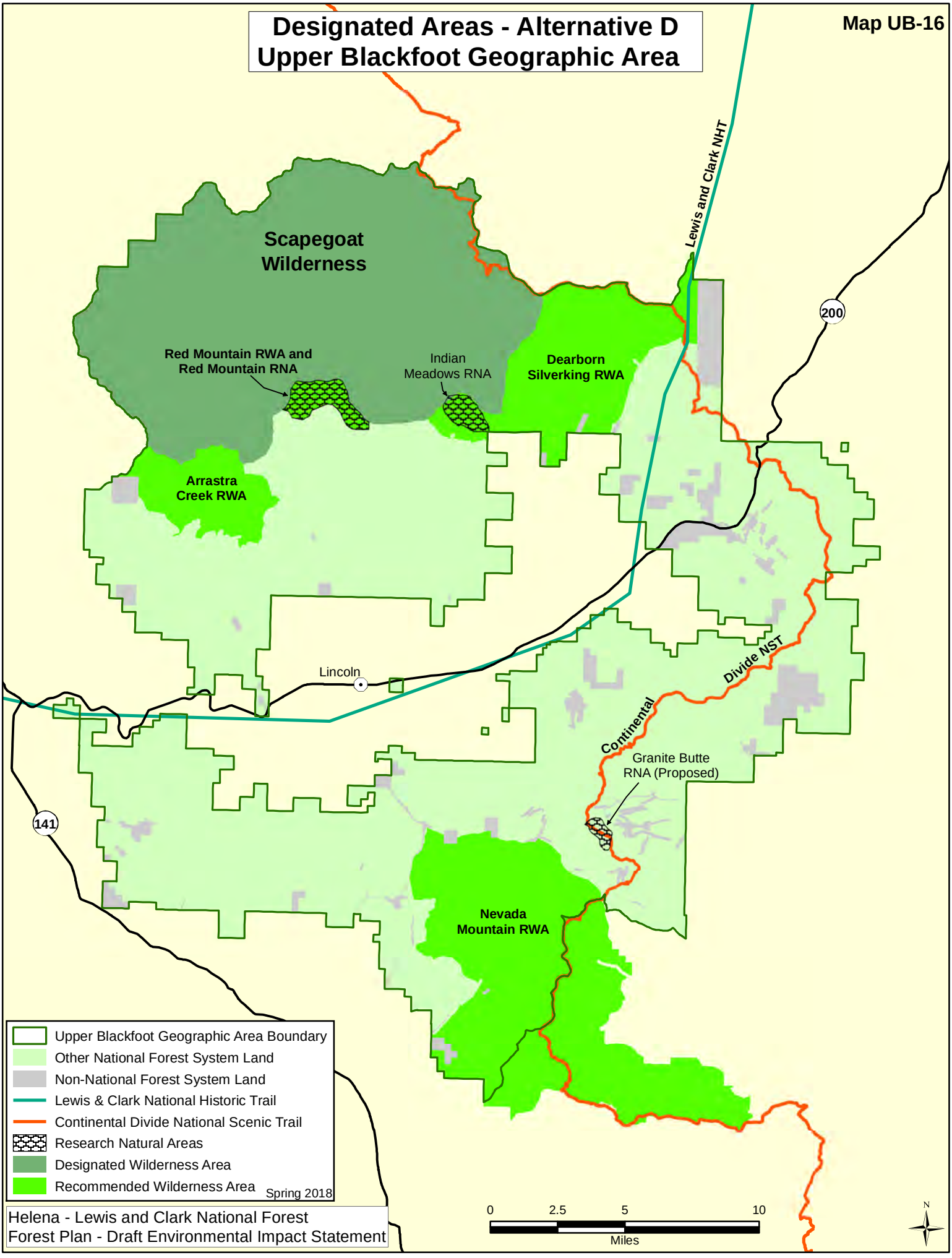
Map UB-13



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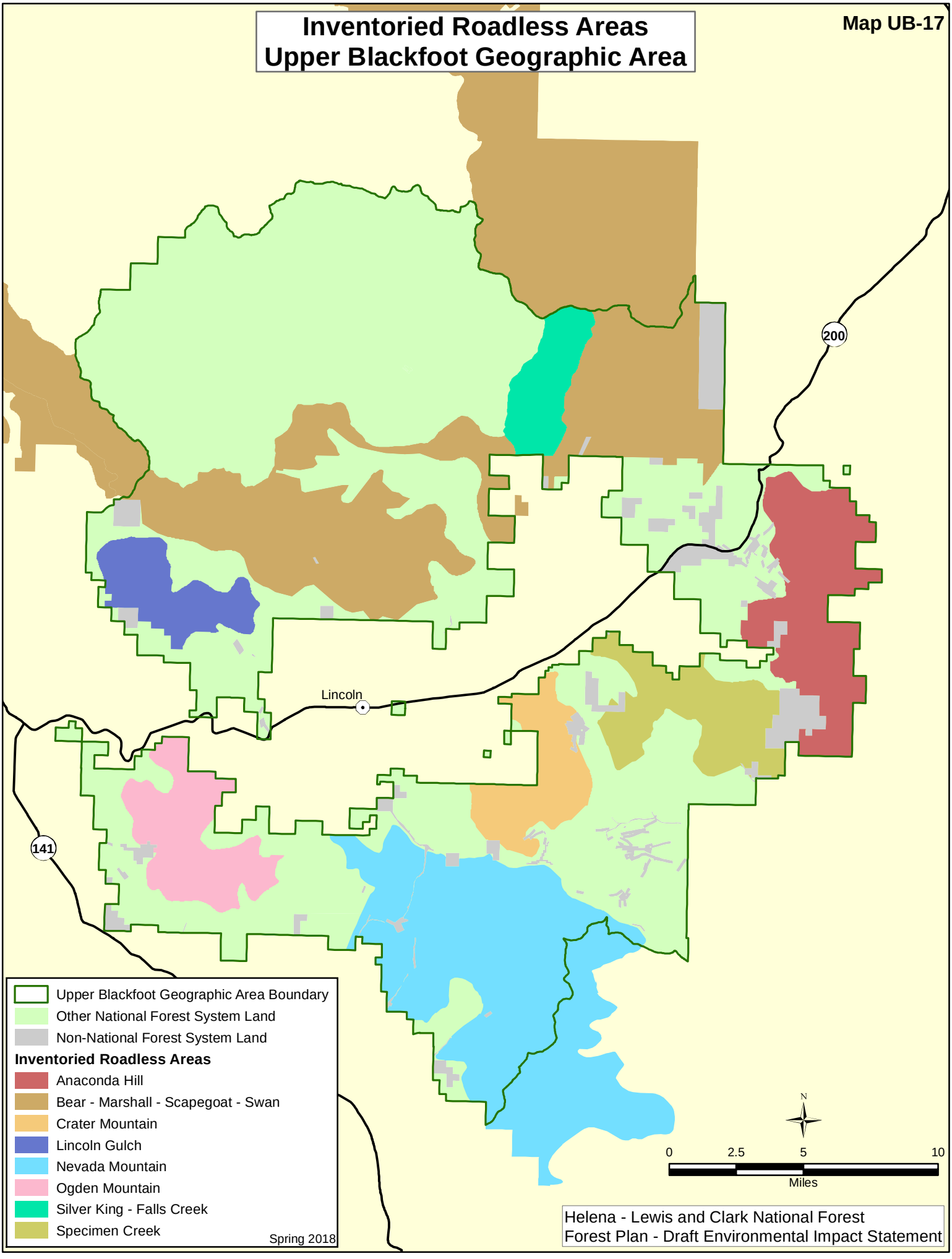

Designated Areas - Alternatives A and E
Upper Blackfoot Geographic Area
Map UB-14
Scapegoat Wilderness
Red Mountain RNA
Indian Meadows RNA
Lewis and Clark NHT
200
Lincoln
Divide NST
Continental
Granite Butte RNA (Proposed)
141
Upper Blackfoot Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Lewis & Clark National Historic Trail
Continental Divide National Scenic Trail
Research Natural Areas
Designated Wilderness Area
Spring 2018
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0
2.5
5
10
Miles
N


Designated Areas - Alternatives B and C
Upper Blackfoot Geographic Area
Map UB-15
Scapegoat Wilderness
Red Mountain RWA and Red Mountain RNA
Indian Meadows RNA
Dearborn Silverking RWA
Arrastra Creek RWA
Lewis and Clark NHT
200
Lincoln
Divide NST
Continental
Granite Butte RNA (Proposed)
141
Nevada Mountain RWA
Upper Blackfoot Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Lewis & Clark National Historic Trail
Continental Divide National Scenic Trail
Research Natural Areas
Designated Wilderness Area
Recommended Wilderness Area
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0
2.5
5
10
Miles
N


Designated Areas - Alternative D
Upper Blackfoot Geographic Area
Map UB-16
Scapegoat Wilderness
Red Mountain RWA and Red Mountain RNA
Indian Meadows RNA
Dearborn Silverking RWA
Arrastra Creek RWA
Lewis and Clark NHT
200
Lincoln
Divide NST
Continental
Granite Butte RNA (Proposed)
141
Nevada Mountain RWA
Upper Blackfoot Geographic Area Boundary
Other National Forest System Land
Non-National Forest System Land
Lewis & Clark National Historic Trail
Continental Divide National Scenic Trail
Research Natural Areas
Designated Wilderness Area
Recommended Wilderness Area
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0
2.5
5
10
Miles
N

Inventoried Roadless Areas
Upper Blackfoot Geographic Area

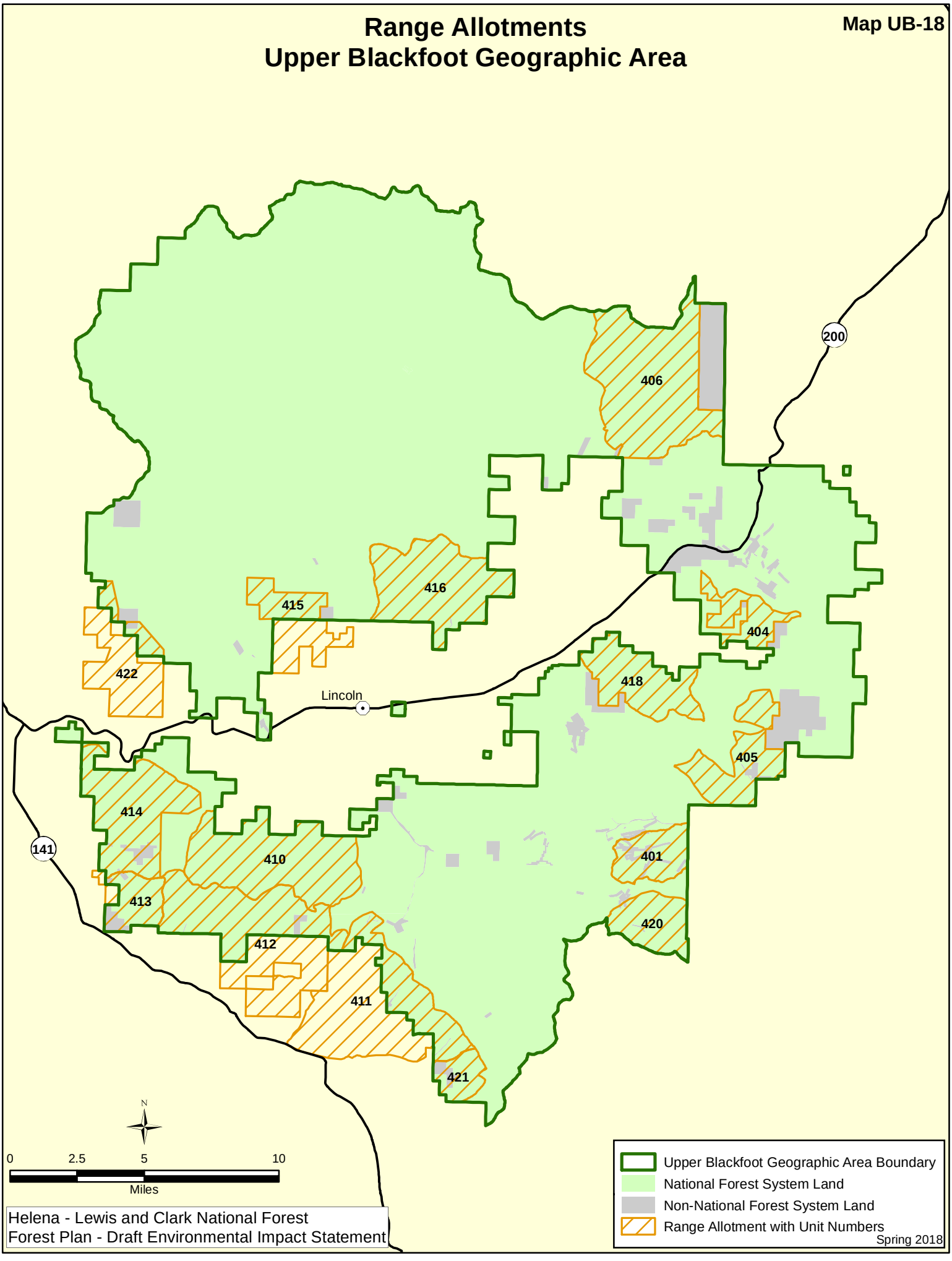
Map UB-17



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Range Allotments
Upper Blackfoot Geographic Area

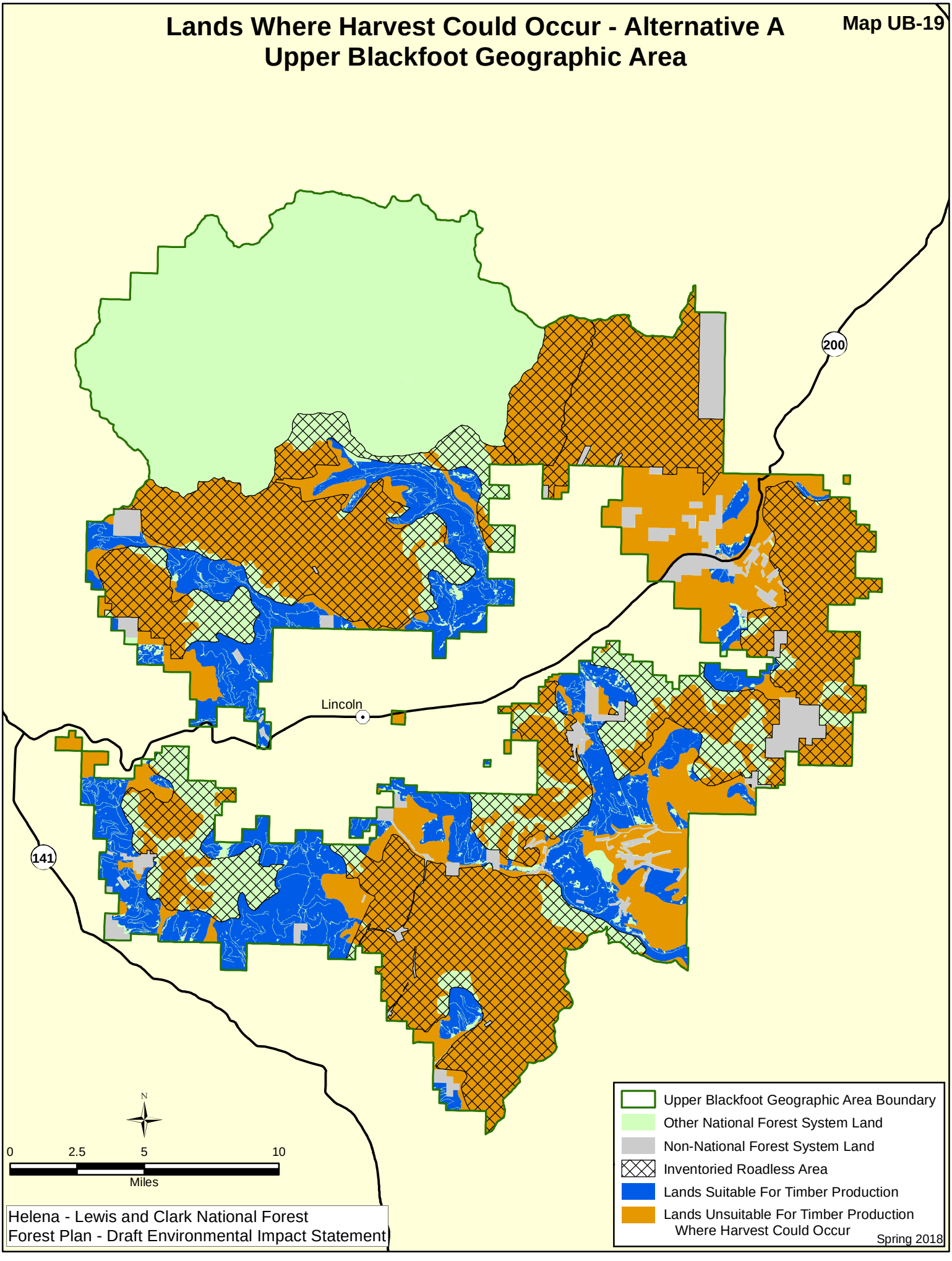
Map UB-18



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Lands Where Harvest Could Occur - Alternative A
Upper Blackfoot Geographic Area

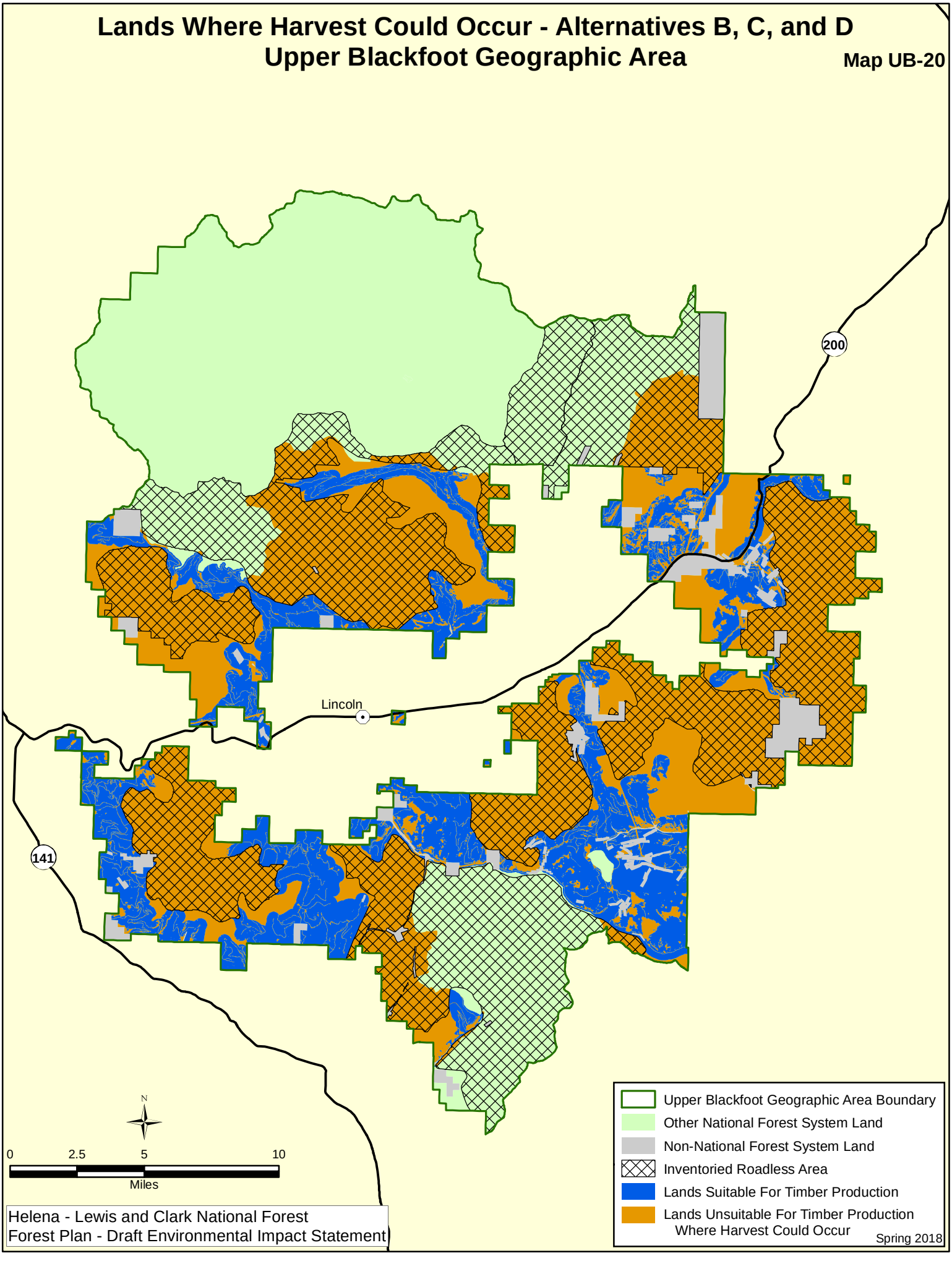
Map UB-19



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Lands Where Harvest Could Occur - Alternatives B, C, and D
Upper Blackfoot Geographic Area

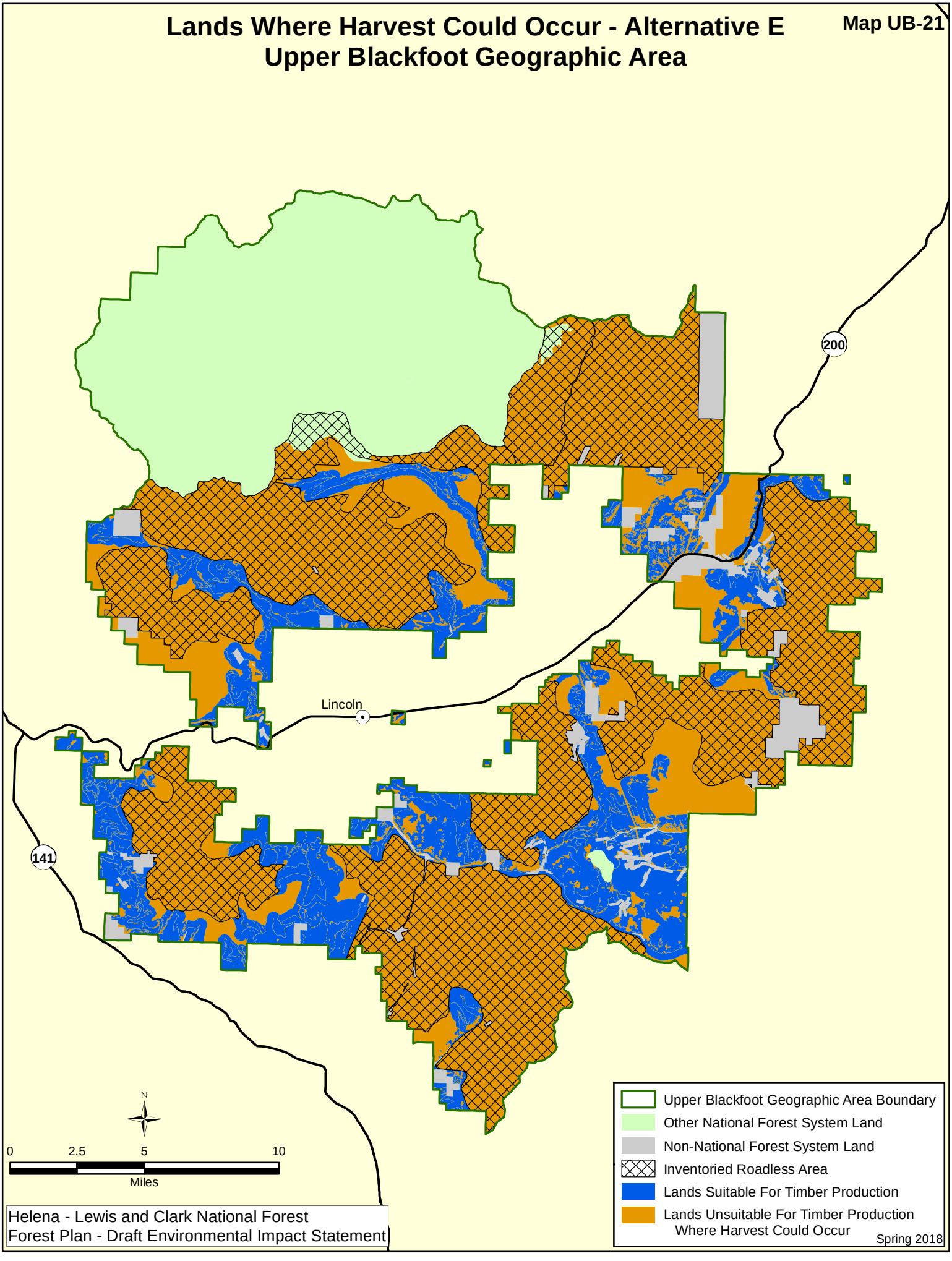
Map UB-20



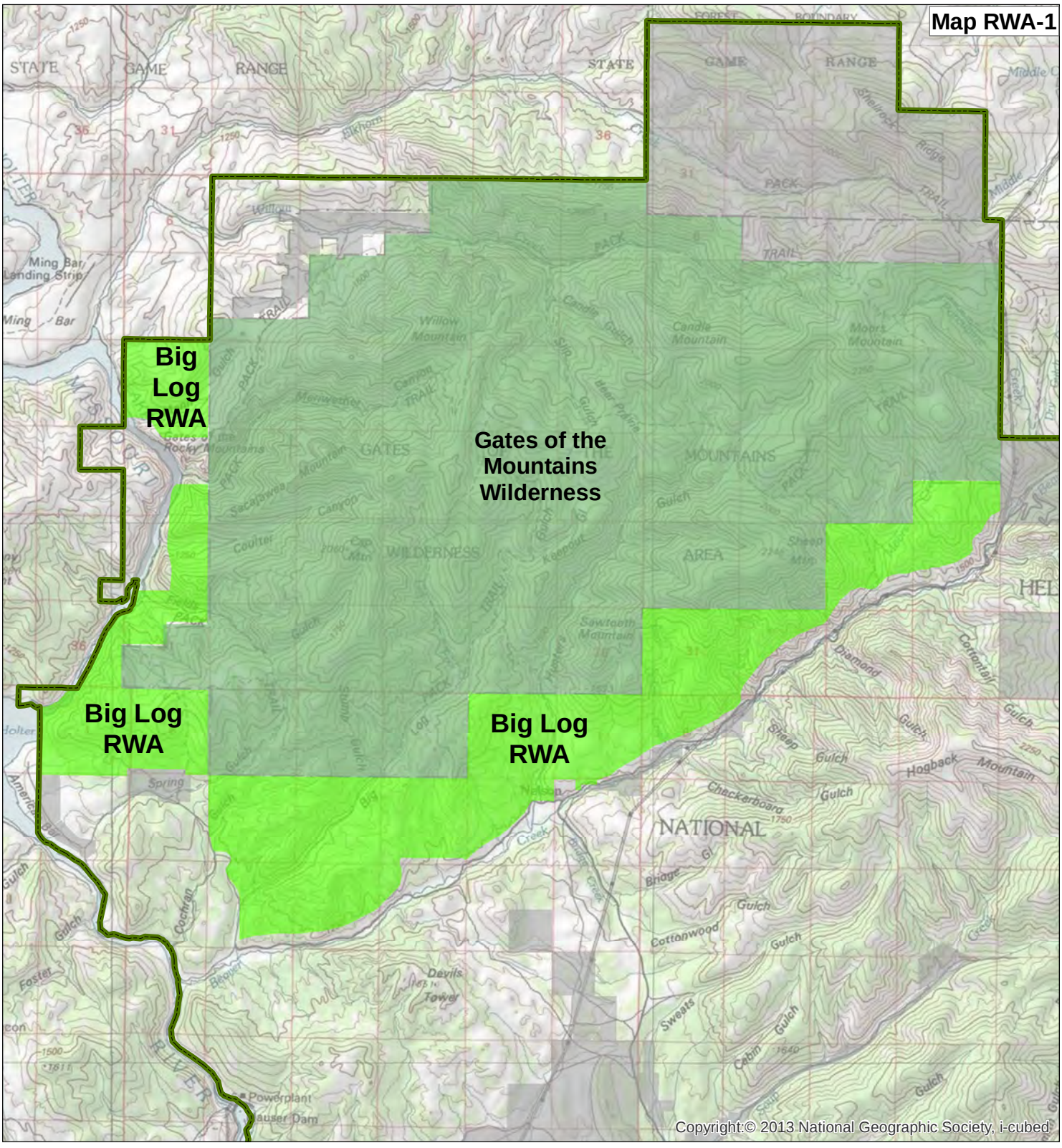
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Lands Where Harvest Could Occur - Alternative E
Upper Blackfoot Geographic Area

Map UB-21



Helena - Lewis and Clark National Forest
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Big Log Recommended Wilderness Area
Alternative A

Forest Service Administrative Boundary

Non-National Forest System Land

Designated Wilderness Area

Recommended Wilderness Area

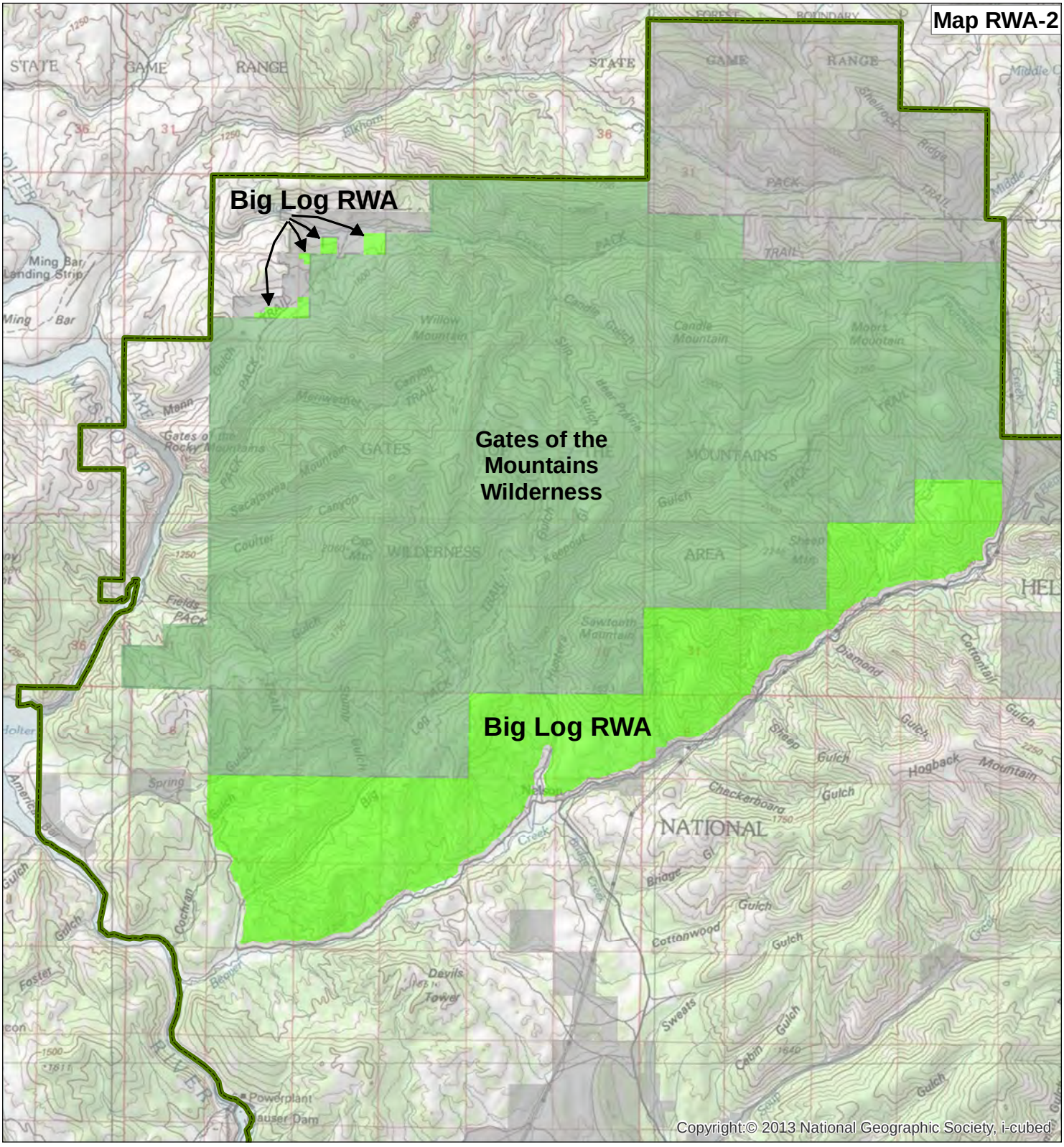
N

0 1 2 4

Miles

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Big Log (BB1) Recommended Wilderness Area
Alternatives B, C, and D

Forest Service Administrative Boundary

Non-National Forest System Land

Designated Wilderness Area

Recommended Wilderness Area

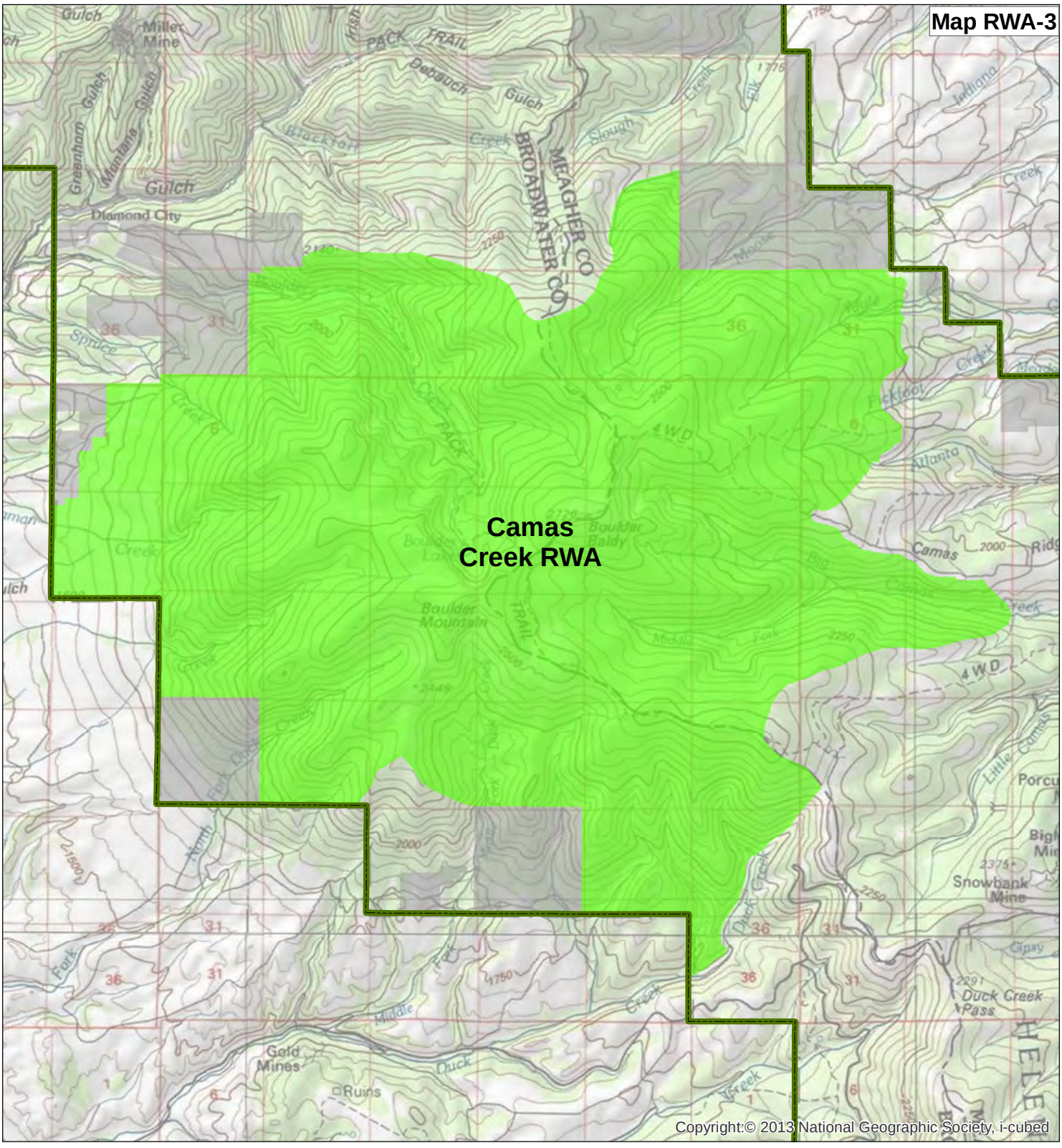
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Camas Creek Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

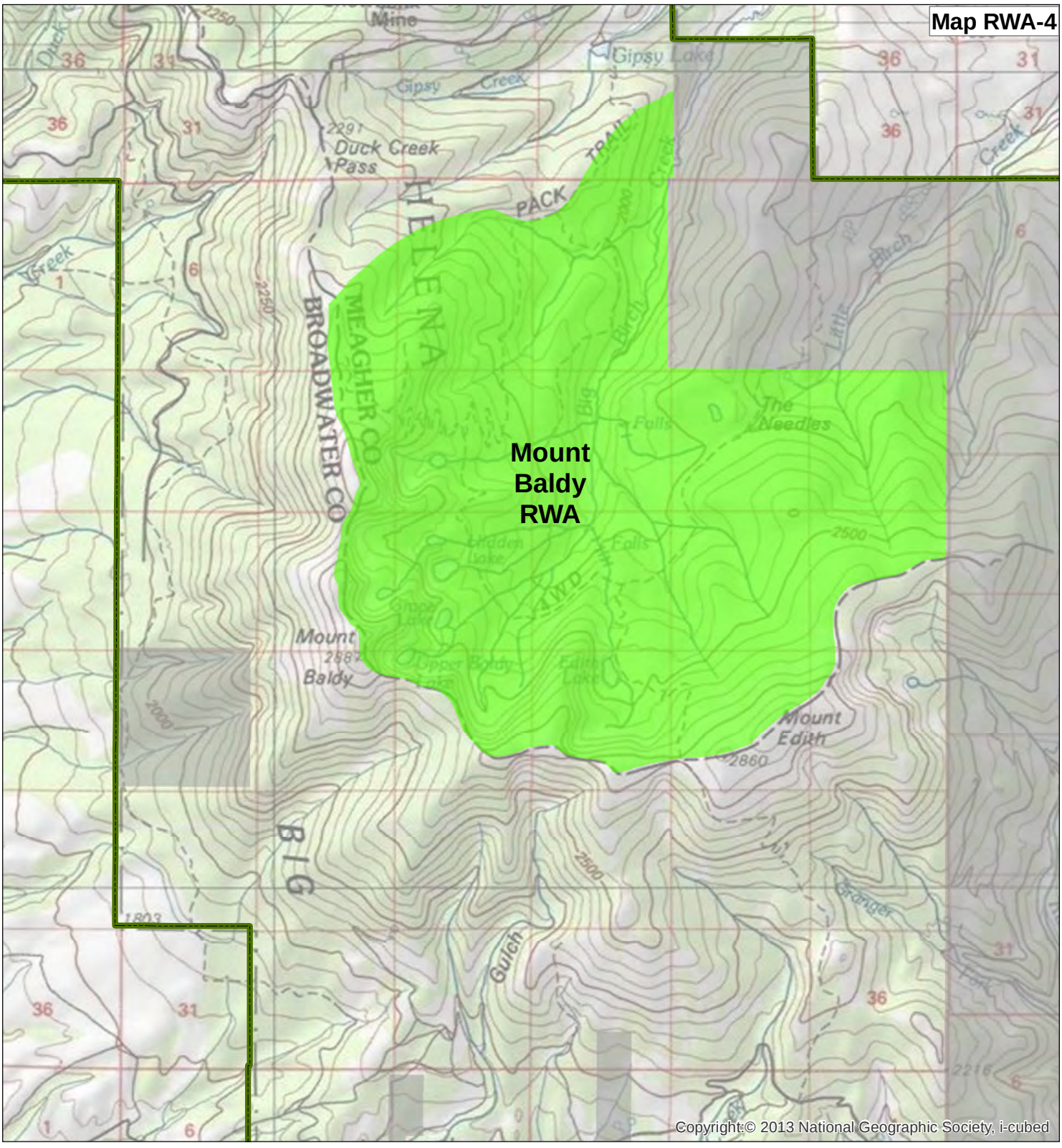
Non-National Forest System Land

N

Helena - Lewis and Clark National Forest
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0 1 2 4
Miles

Spring 2018



Mount Baldy Recommended Wilderness Area
Alternative A

Forest Service Administrative Boundary

Non-National Forest System Land

Recommended Wilderness Area

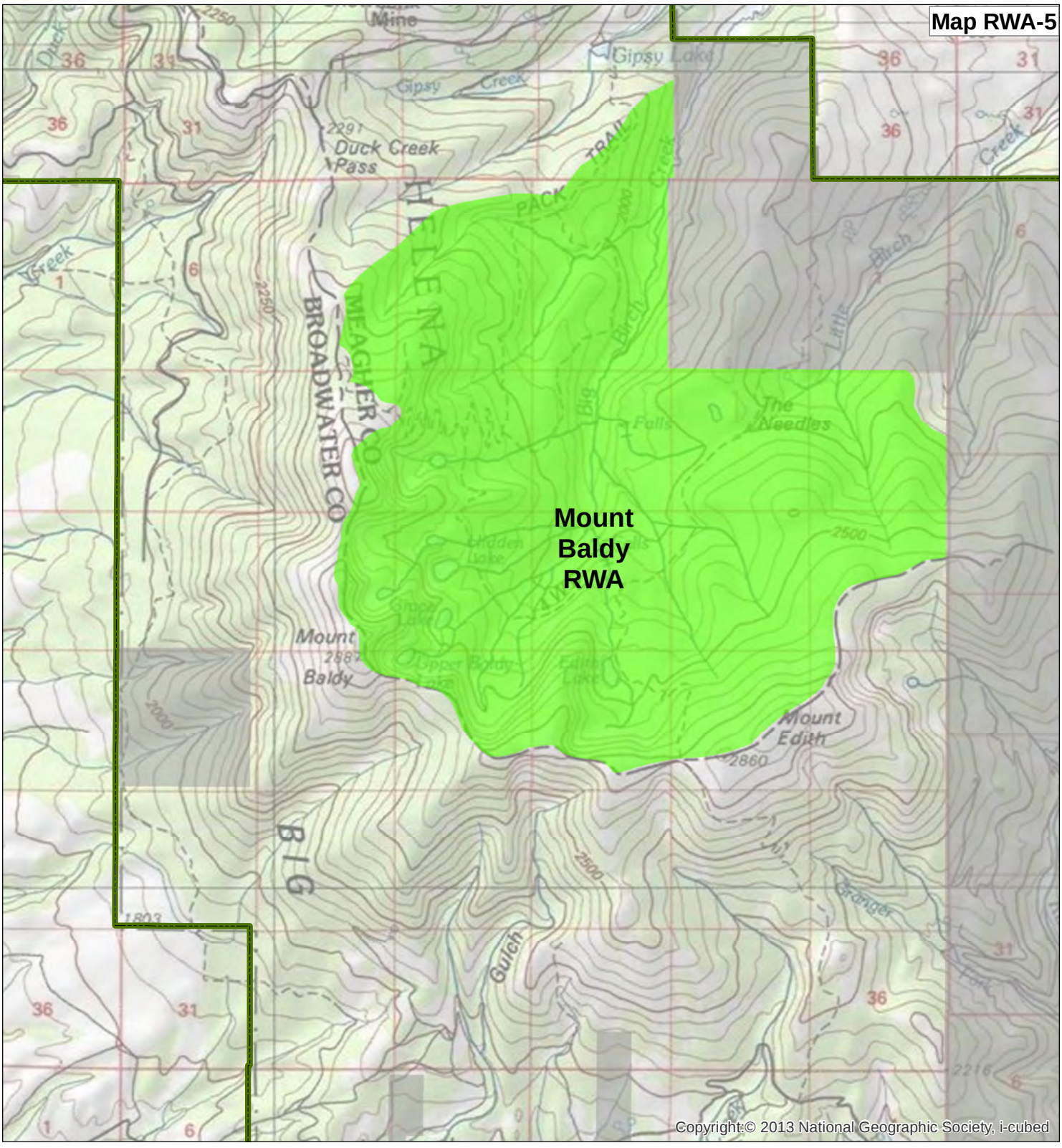
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Mount Baldy Recommended Wilderness Area
Alternatives B, C, and D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

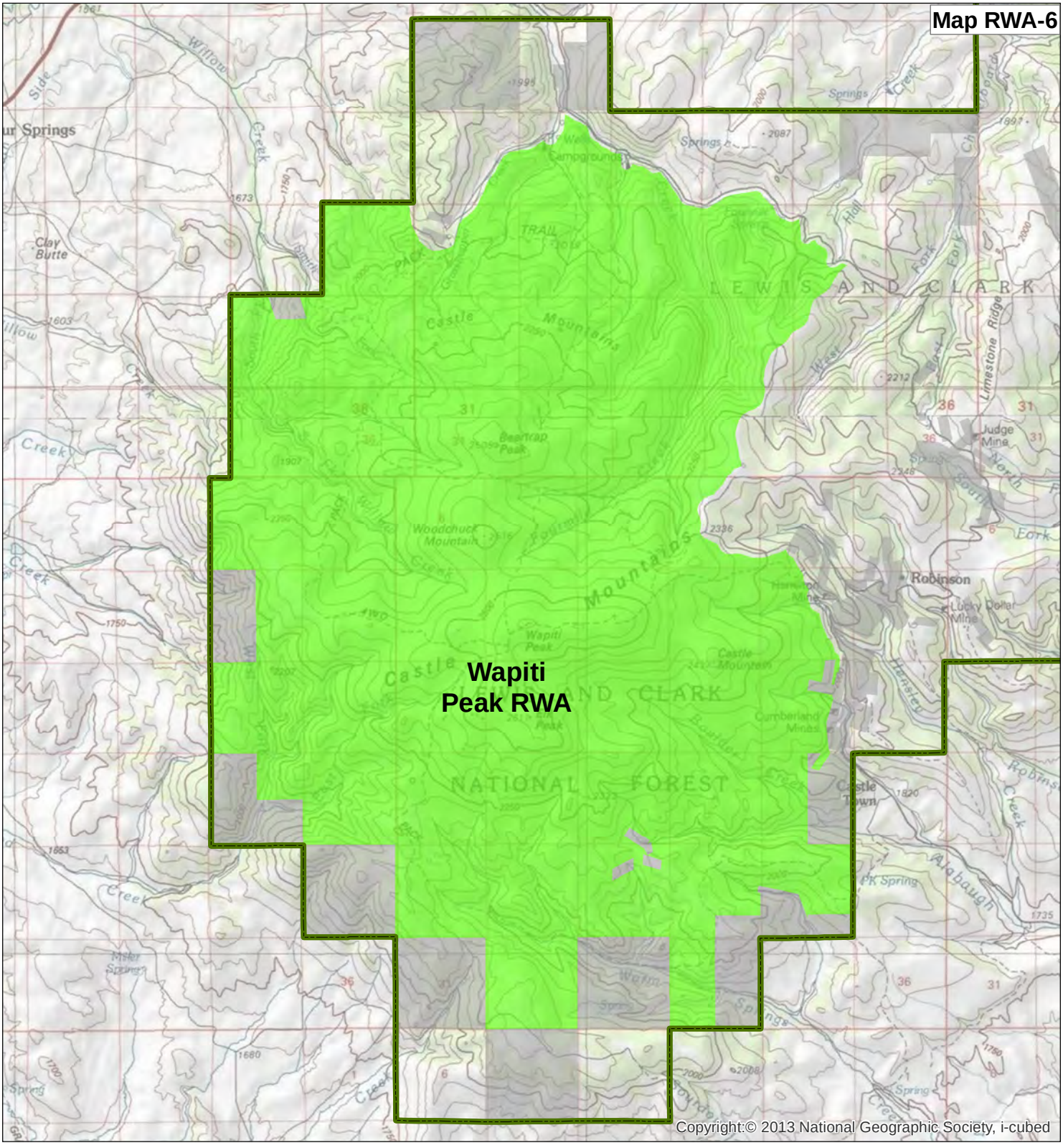
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Wapati Peak Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

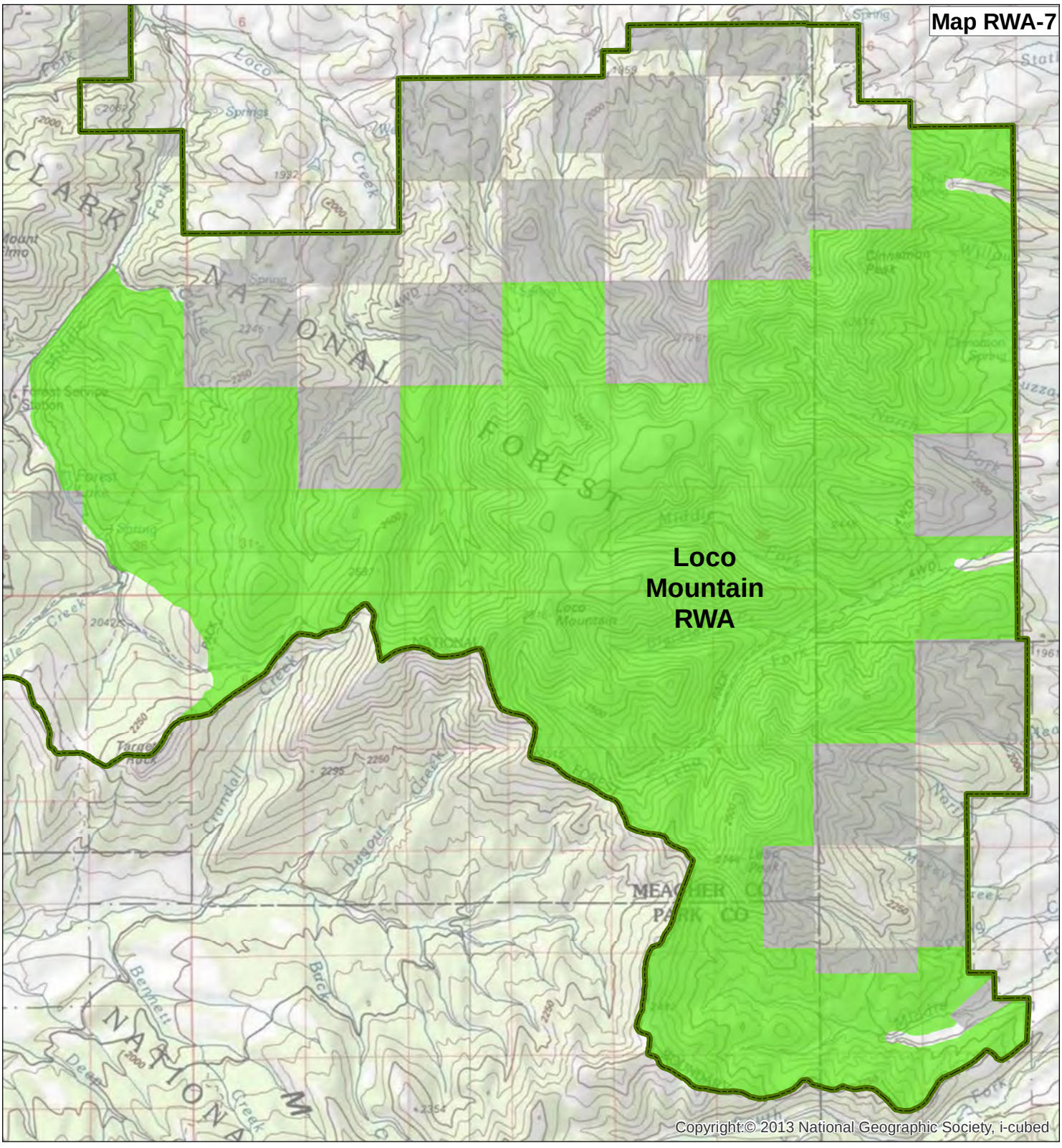
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Loco Mountain Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

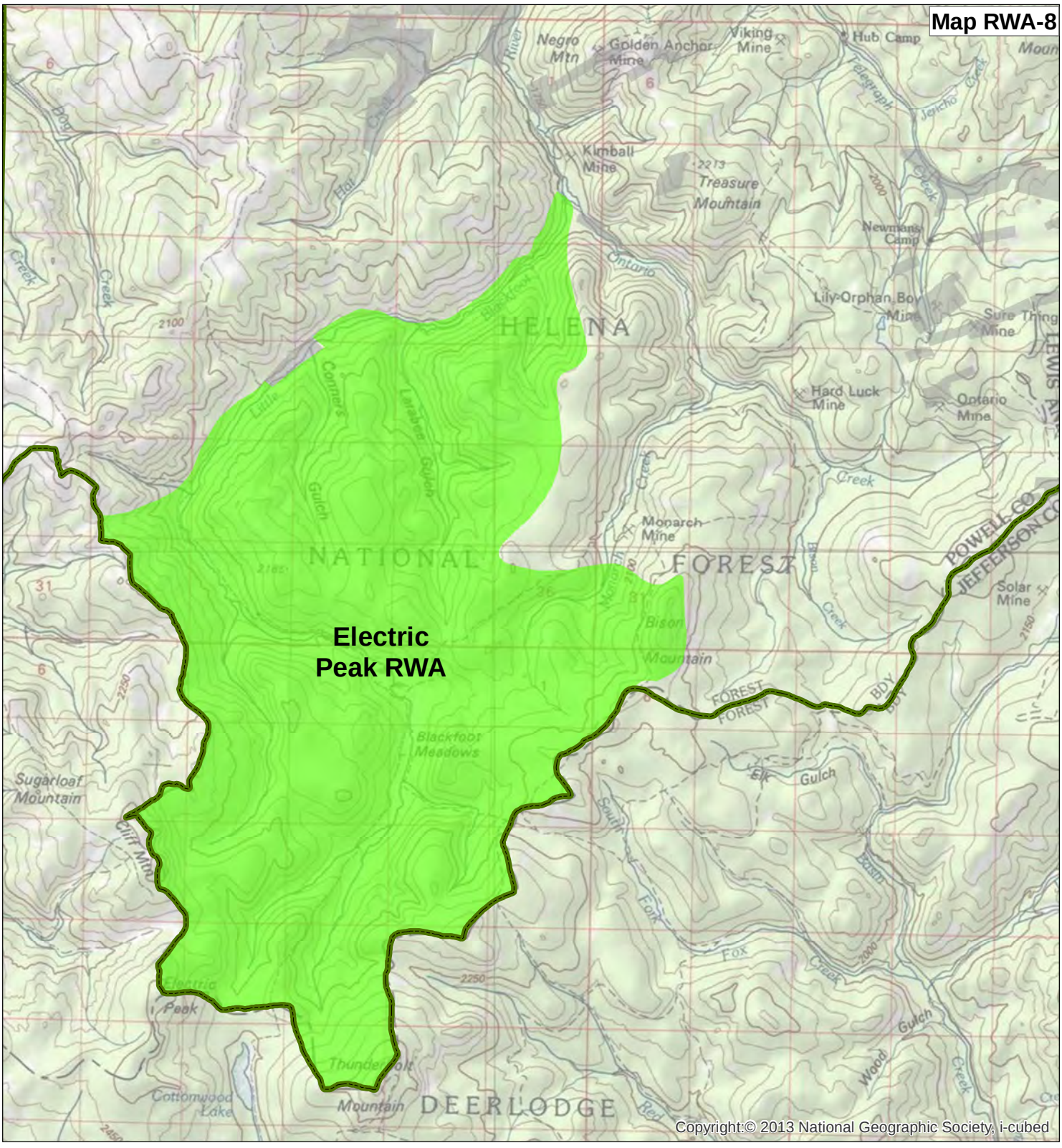
Non-National Forest System Land

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Miles

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Spring 2018



Electric Peak Recommended Wilderness Area
Alternative A

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

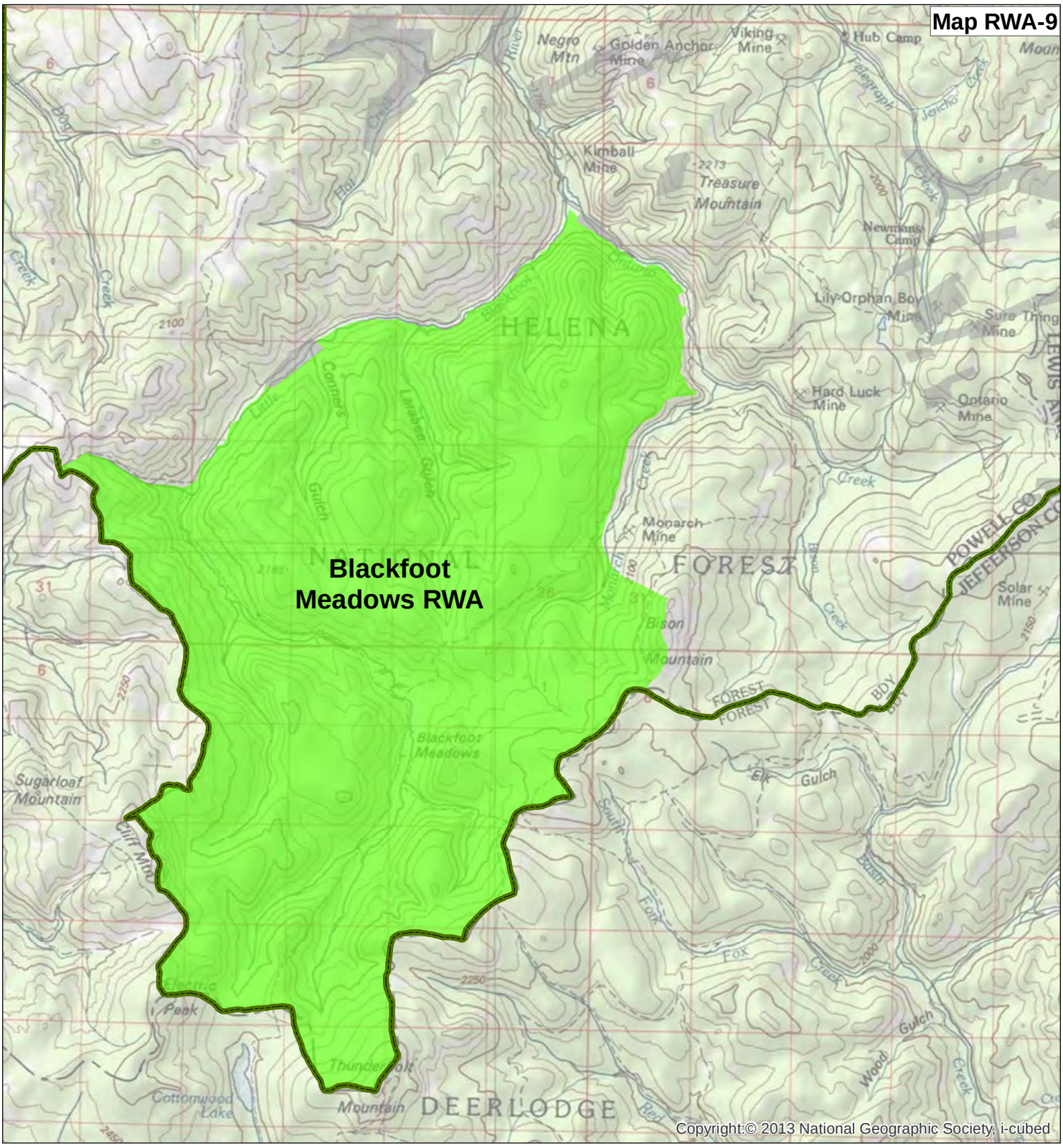
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Blackfoot Meadows Recommended Wilderness Area
Alternatives B and C

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

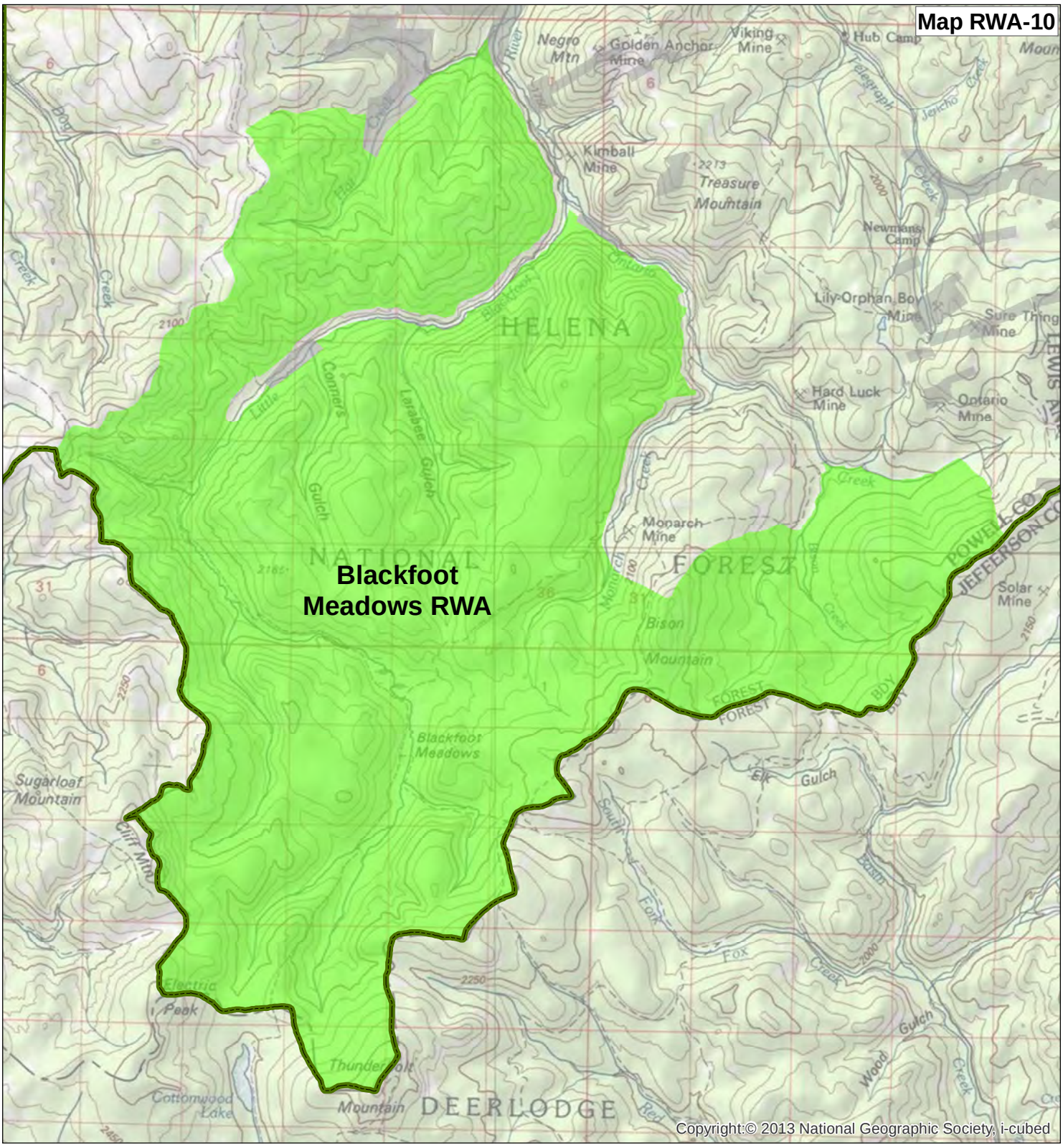
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Blackfoot Meadows Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

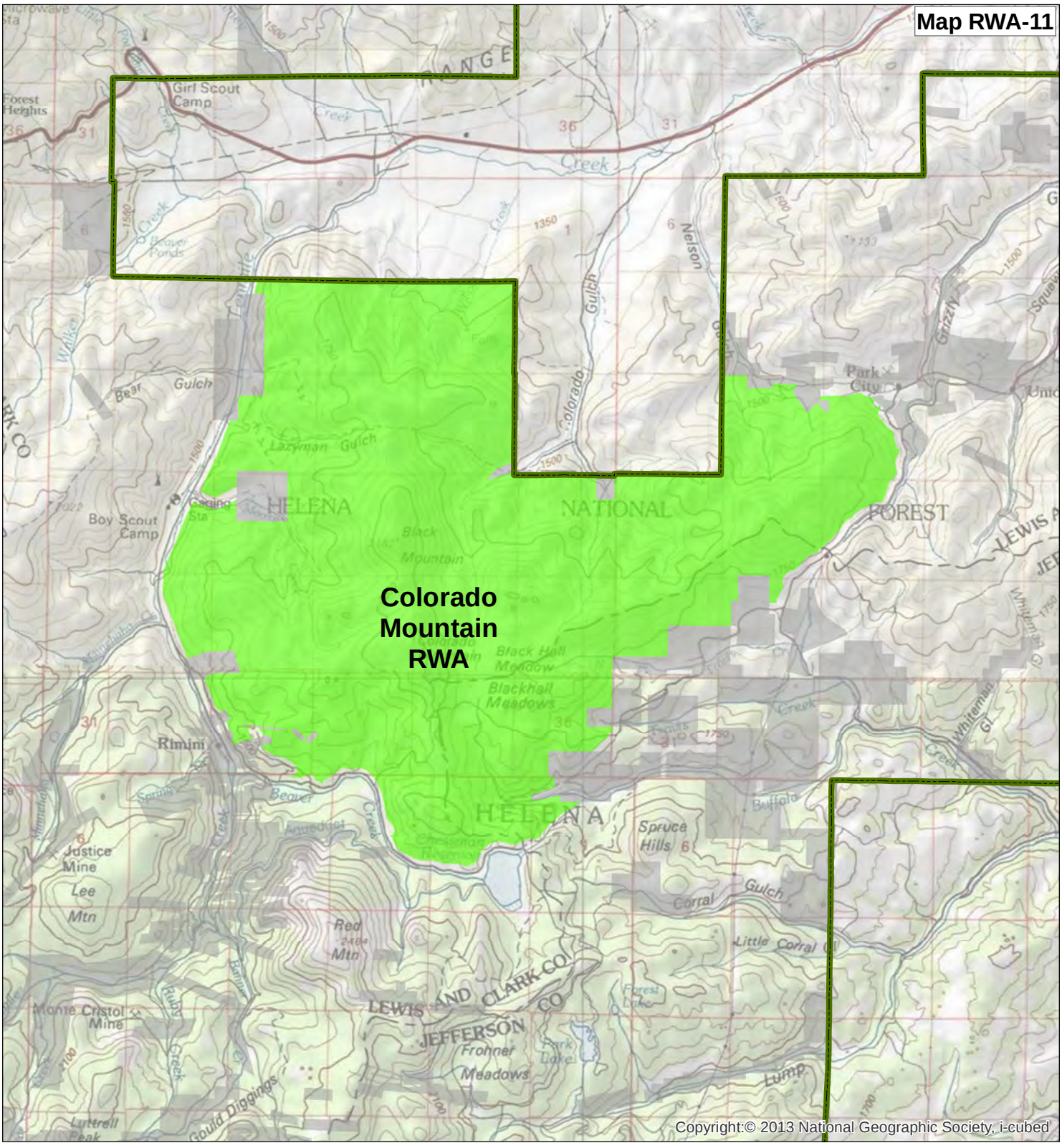
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Colorado Mountain Recommended Wilderness Area Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

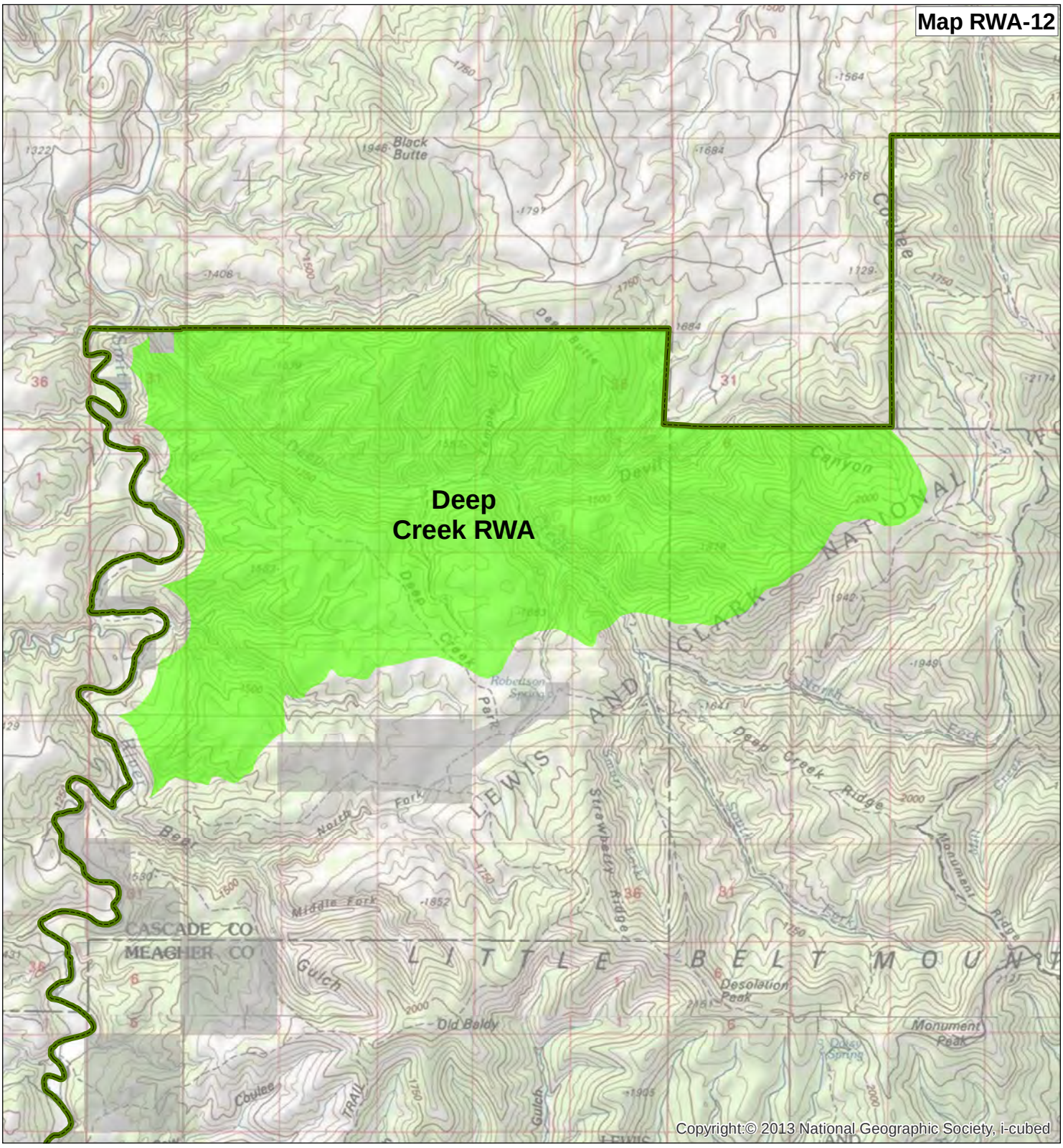
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Miles

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Deep Creek Recommended Wilderness Area
Alternatives B, C, and D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

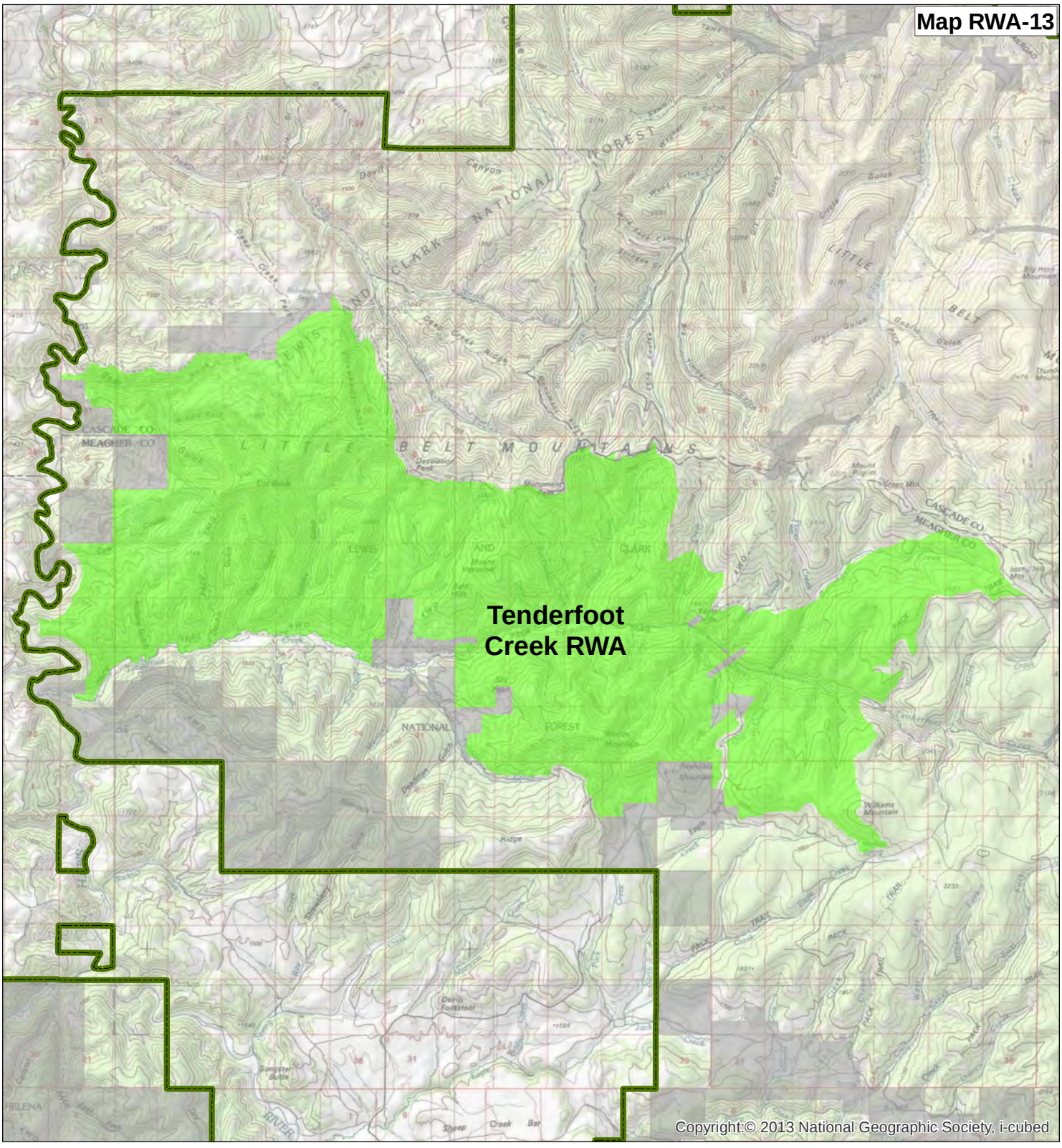
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Tenderfoot Creek Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

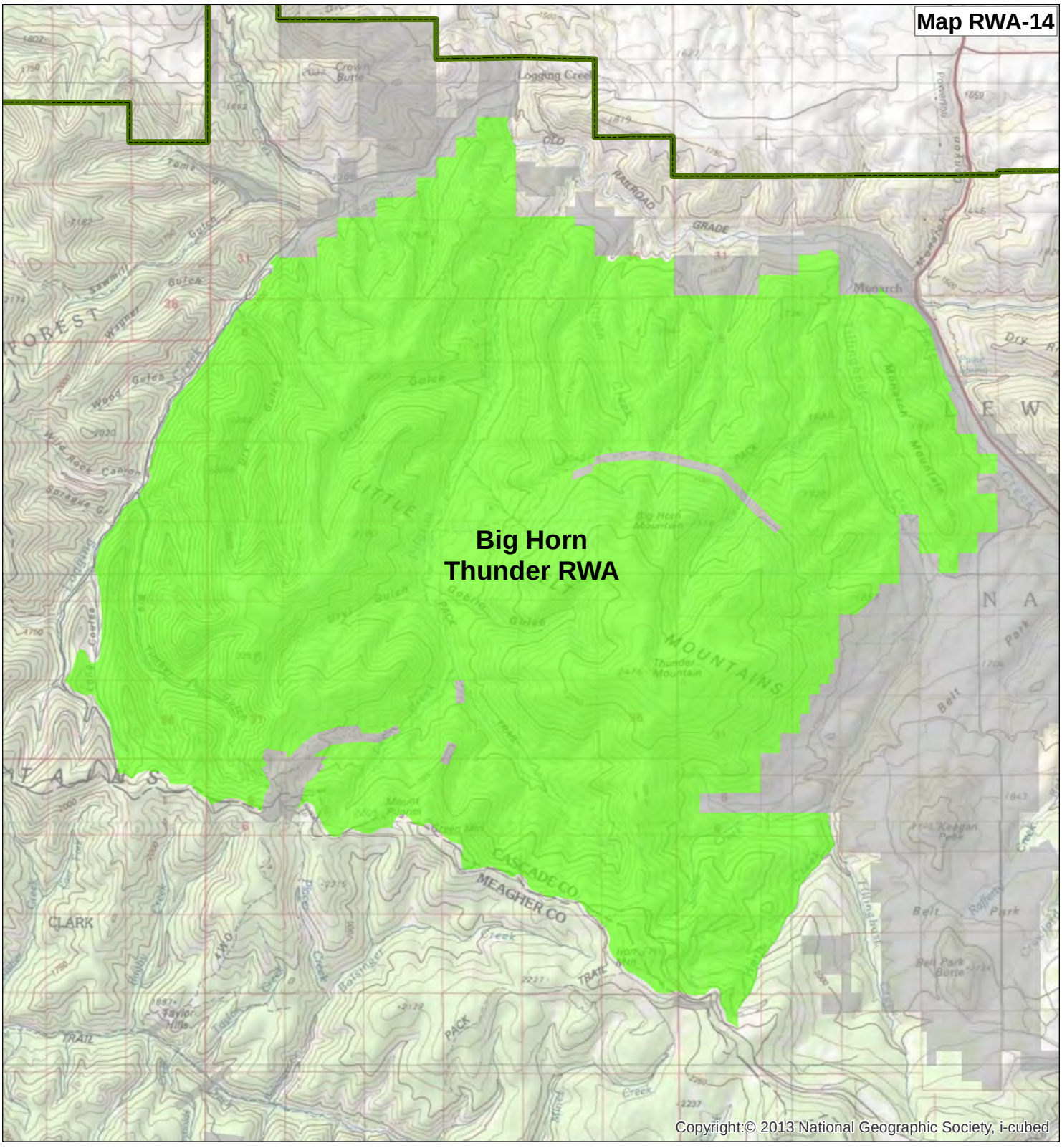
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0 2 4 8

Miles

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Big Horn Thunder Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

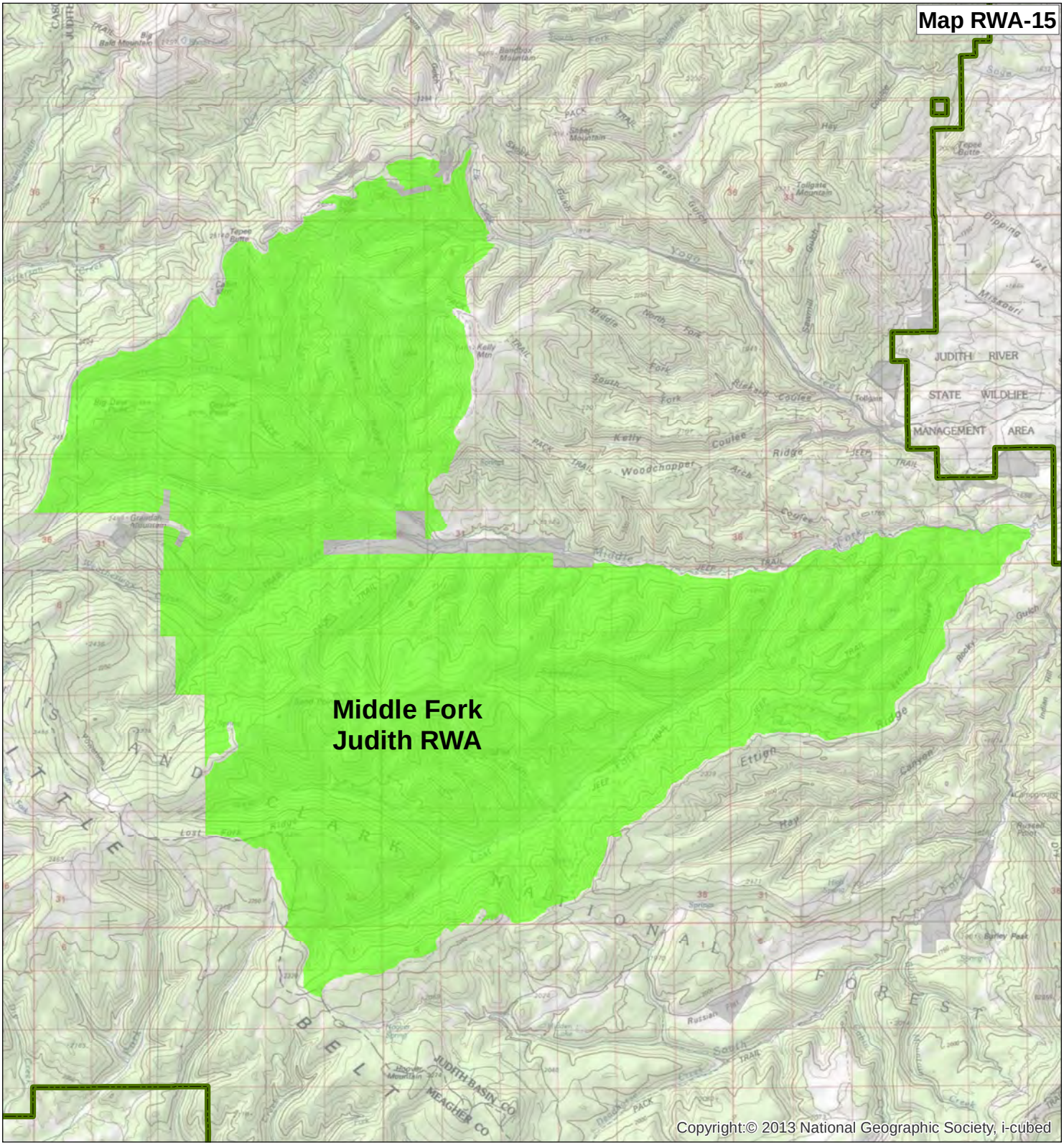
Non-National Forest System Land

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0 1 2 4
Miles

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Spring 2018



Middle Fork Judith Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

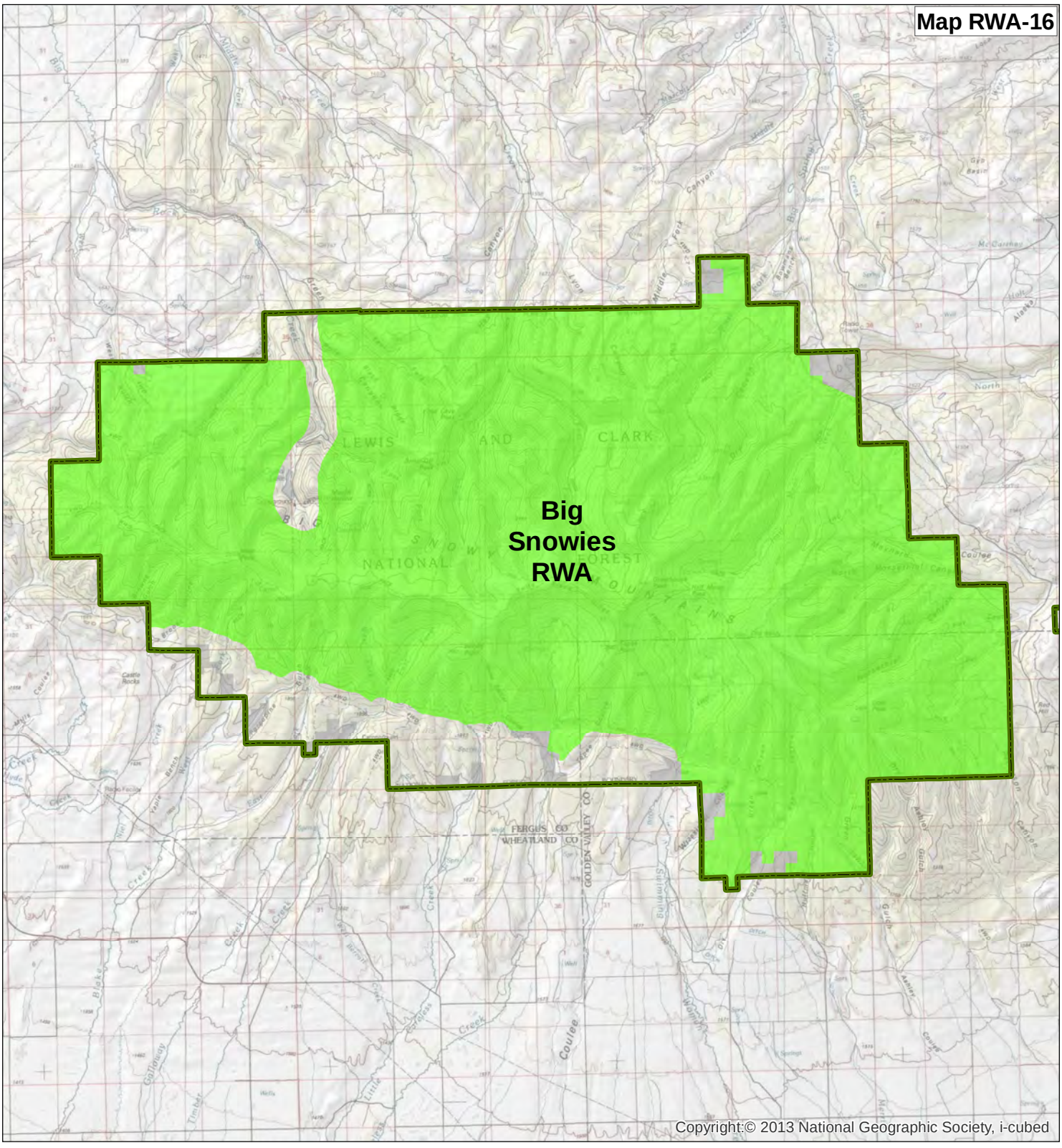
Non-National Forest System Land

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0 1.5 3 6
Miles

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Spring 2018



Big Snowies Recommended Wilderness Area
Alternatives B, C and D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

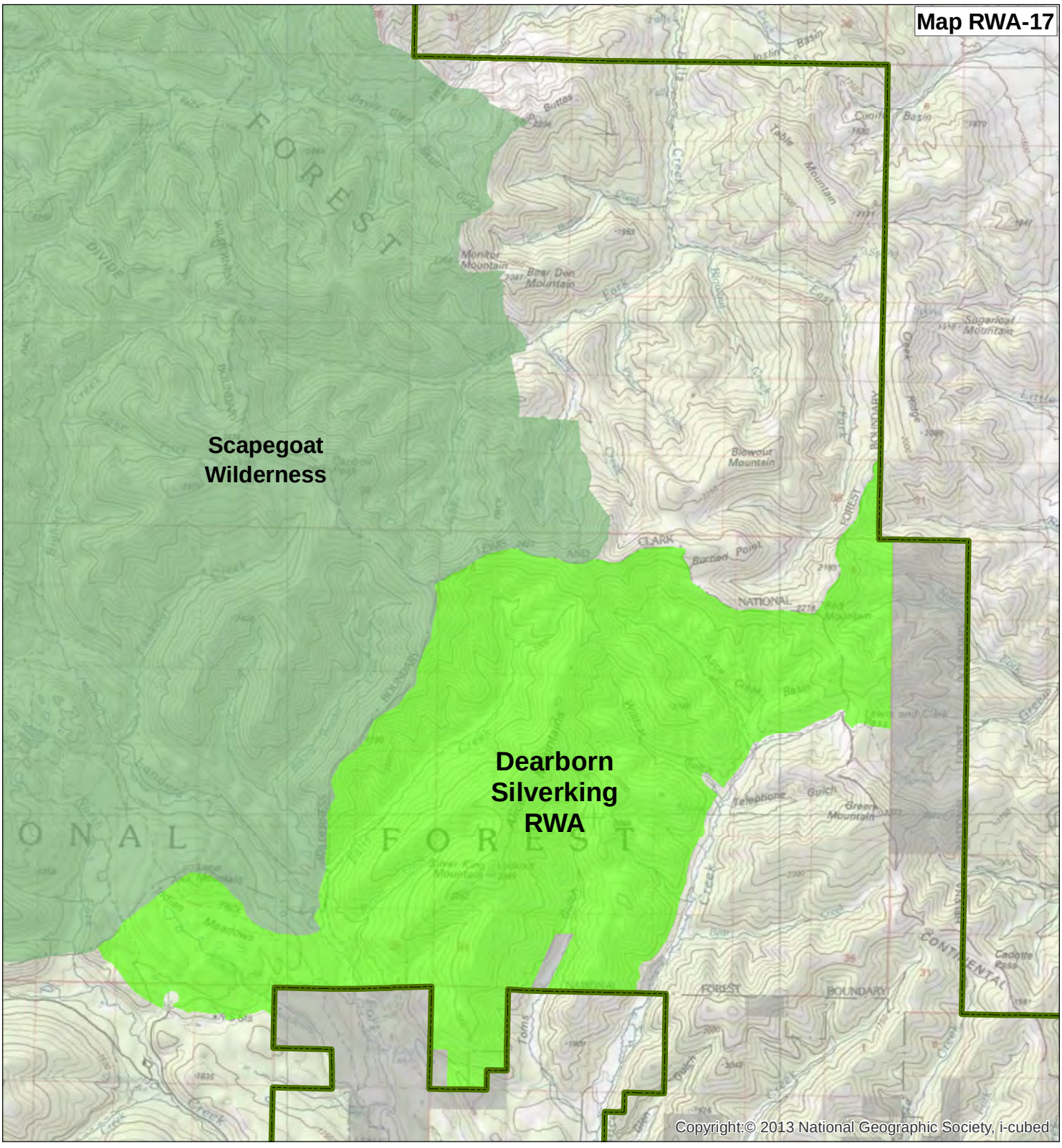
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Miles

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Dearborn Silverking Recommended Wilderness Area
Alternatives B, C and D

Forest Service Administrative Boundary

Non-National Forest System Land

Designated Wilderness Area

Recommended Wilderness Area

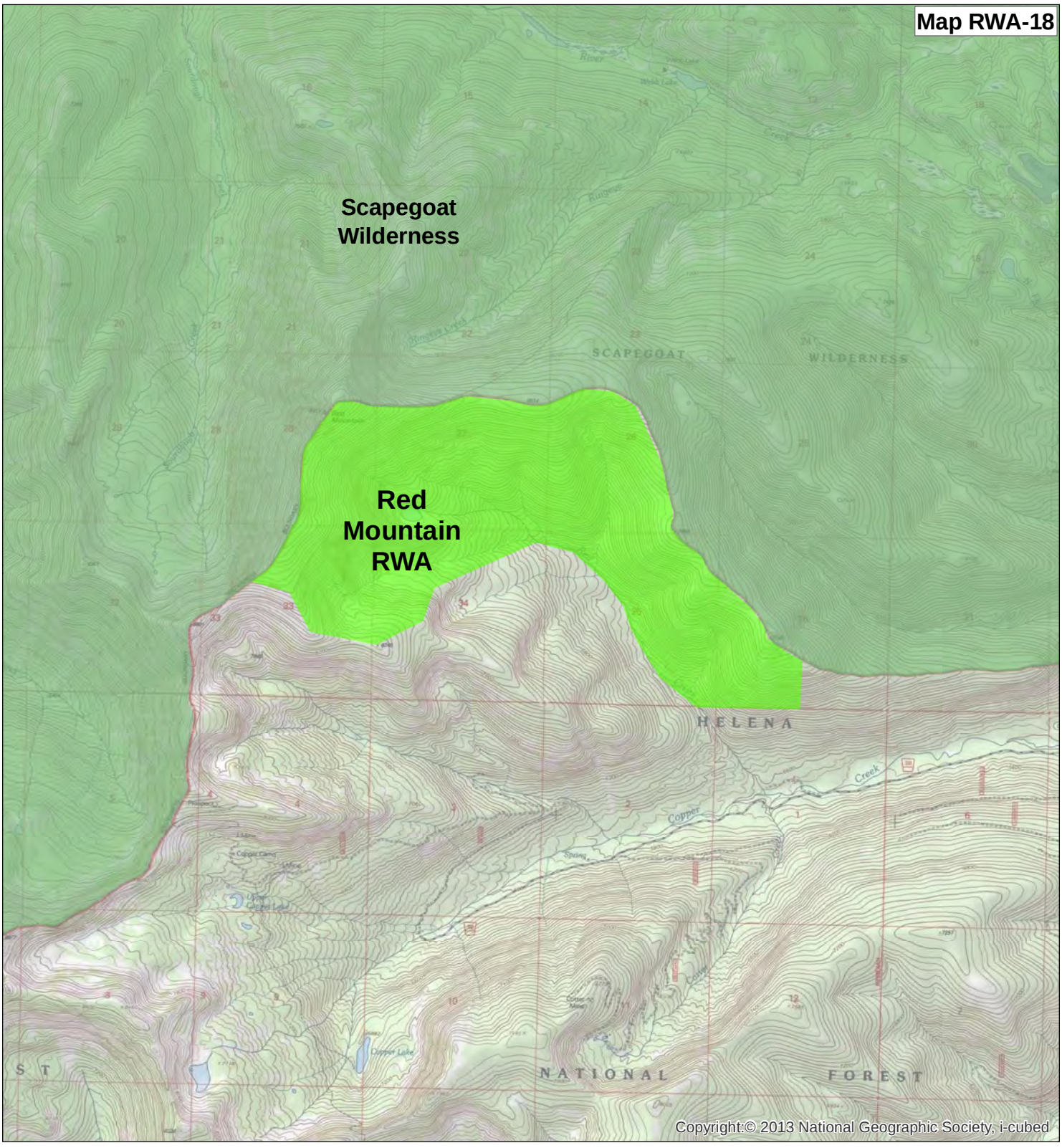
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Red Mountain Recommended Wilderness Area
Alternatives B, C and D

Forest Service Administrative Boundary

Non-National Forest System Land

Designated Wilderness Area

Recommended Wilderness Area

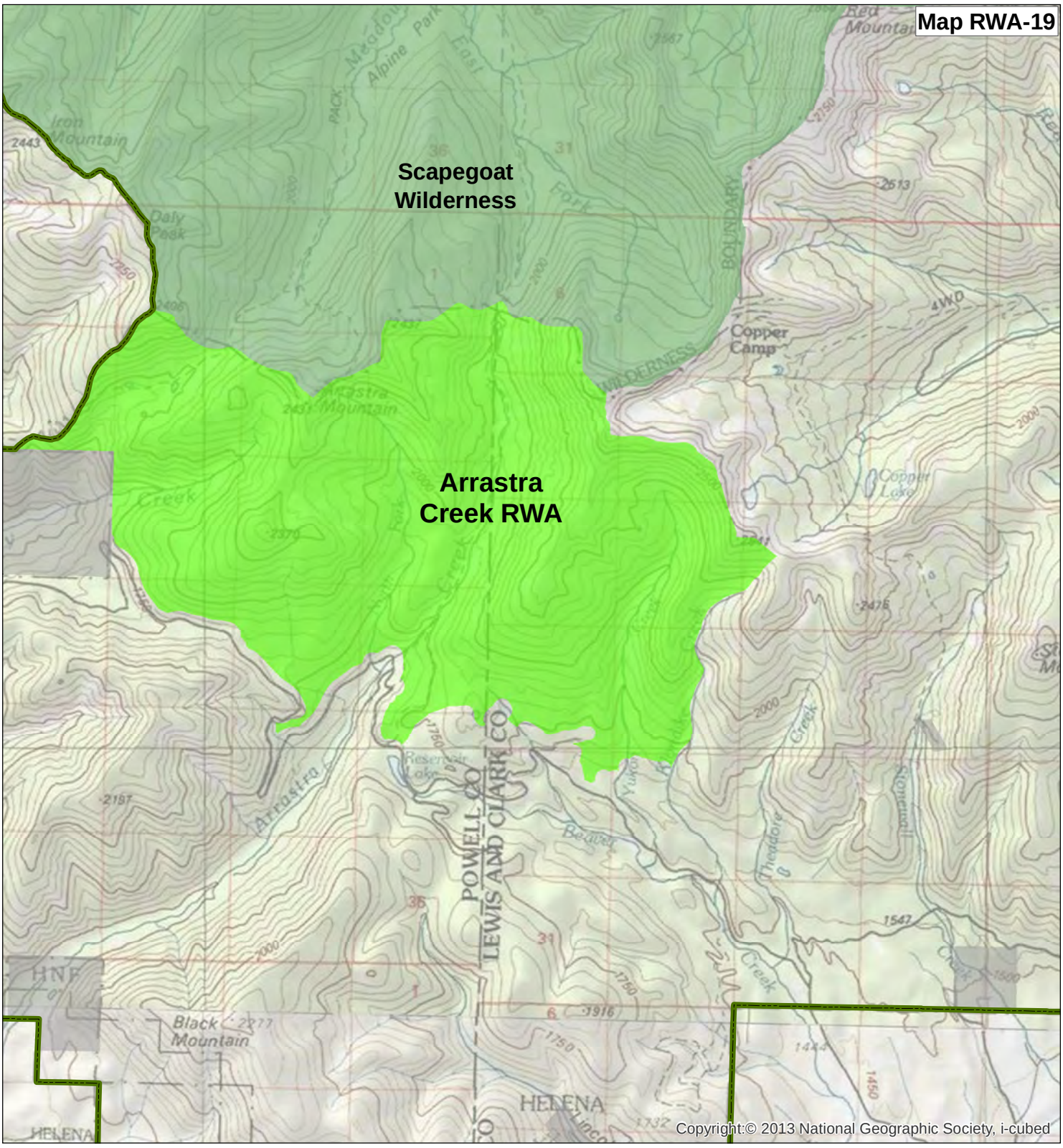
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Arrastra Creek Recommended Wilderness Area
Alternatives B, C, and D

Forest Service Administrative Boundary

Non-National Forest System Land

Designated Wilderness Area

Recommended Wilderness Area

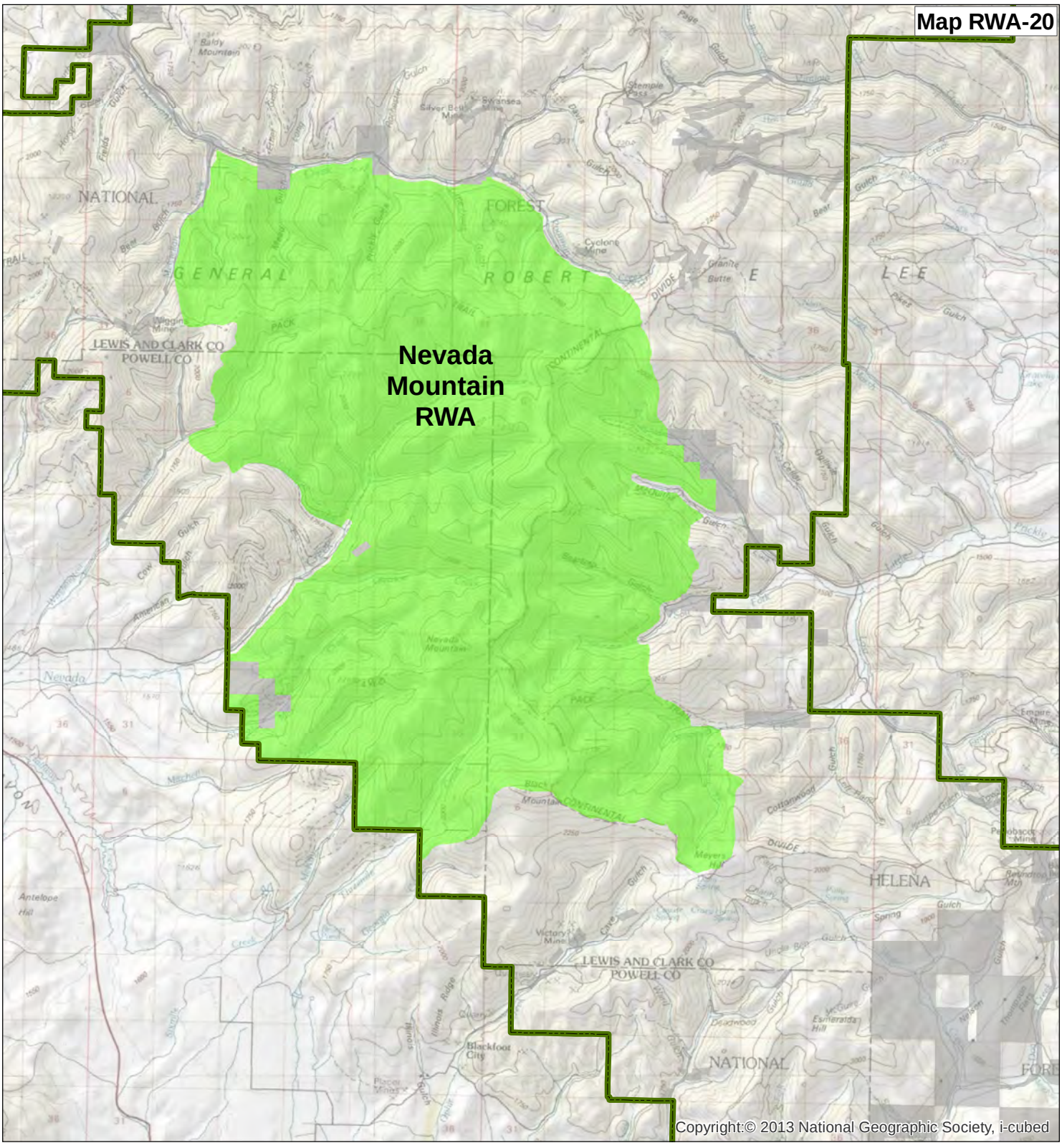
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Nevada Mountain Recommended Wilderness Area
Alternatives B and C

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

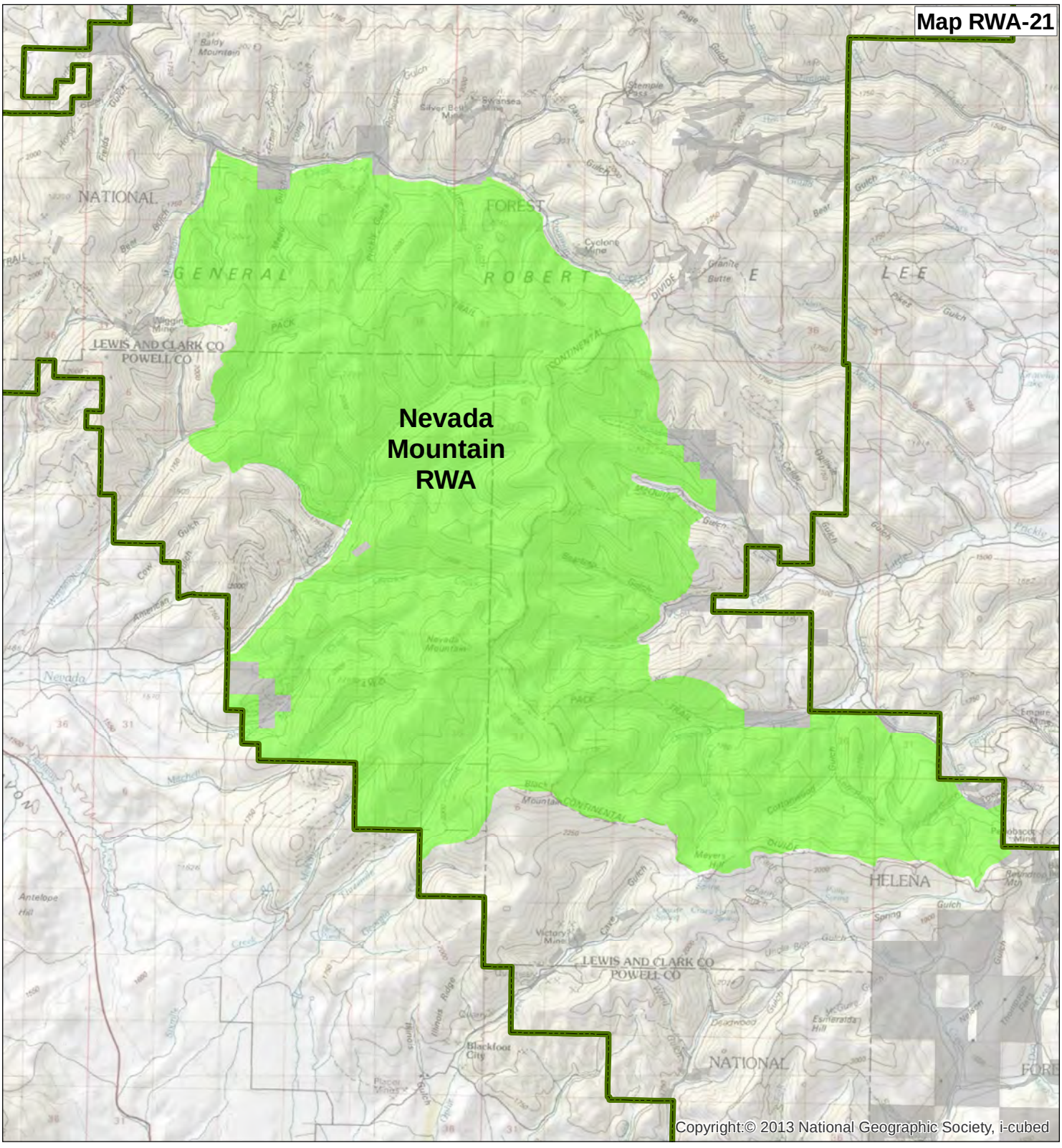
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Nevada Mountain Recommended Wilderness Area
Alternative D

Forest Service Administrative Boundary

Recommended Wilderness Area

Non-National Forest System Land

N

0 1 2 4

Miles

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Appendix B. Methodologies and Modeling Results

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Introduction

This appendix includes the methodologies used by all of the resource areas analyzed. They are arranged in the same order as the resources in chapter 3.

In addition, for some resource areas, detailed modeling results (figures and tables) are included to supplement the conclusions summarized in the DEIS. The modeling results are generated from several vegetation models (SIMPPLLE and Spectrum). The methodologies for these models are detailed in the Terrestrial Vegetation and Timber sections respectively. The model outputs are inserted into the appropriate resource sections which reference them in the DEIS, including Fire and Fuel Management, Terrestrial Vegetation, Old Growth, Snags and Downed Wood, At-Risk Terrestrial Wildlife, Elk, and Timber.

Aquatic Ecosystems

The approach used in this analysis is to take a programmatic look at the outcomes that may result from implementing the proposed management direction in each alternative. For estimating the effects at the programmatic-forest plan level, the assumption has been made that the kinds of resource-management activities allowed under the plans direction are reasonably foreseeable future actions to achieve the goals and objectives. However, the specific location, design, and extent of such activities are not known at the time plans are revised. Project-level decisions are made based on site-specific analysis (project level) basis. Therefore, the discussions here refer to the potential for the effect to occur and are in many cases only estimates. The effects analyses are useful when comparing and evaluating alternatives, but is not intended to be applied directly to specific locations on the forest.

The forest plan prescribes no specific activity in any location; potential spatial and temporal effects to water quality cannot be attributed to any specific watershed. In other words, the cumulative effects of a program at the forest plan scale as opposed to the effects from a project at the project scale can only be discussed in terms of general programmatic tendencies either toward improved or declining water quality or fisheries habitat at no specific site. Therefore, the potential cumulative effects from forest programs to water quality are generally discussed at the basin or HLC NF level. The temporal scale for this analysis is limited to the life of this plan, generally 10 to 15 years.

Analysis Area

The analysis area for the watershed, soils and aquatic species include all the lands within the boundary of the HLC NF and connected waterways. The connected river systems are included because migratory bull trout and westslope cutthroat trout that emerge from Forest streams move downstream to reach sexual maturity and then return to their natal streams to complete the spawning cycle and depend on connectivity for their survival.

The Forest Plan area is located within two HUC Regions:

- The Missouri Region (HUC = 10) is on the eastern side of the Continental Divide. Within this region, the plan area is located in 3 subregions: Missouri Headwaters (HUC=1002), Missouri-Marias (HUC=1003), and Missouri-Musselshell (HUC=1004). Within these subregions, the plan area is located in 14 fourth level watersheds. Within these fourth level watersheds the plan area is located within 88 fifth level watersheds which are further broken down into 301 sixth level watersheds.
- The Pacific Northwest Region (HUC = 17) drains to the west. Within this region, the plan area is located in one subregion, the Kootenai-Pend Oreille- Spokane (HUC=1701). Within this subregion, the plan area is located in two fourth level watersheds: Upper Clark Fork and Blackfoot River.

Within these fourth level watersheds, the plan area is within 16 fifth level watersheds which are further broken down into 72 sixth level subwatersheds.

The analysis scale varies by resource and uses the fourth, fifth and sixth level watershed scales to assess current conditions across the HLC NF.

Air Quality

The air quality analysis relies on existing and most current analysis, research, and planning documents. We used information from several government, academic and private partnership consortiums that have conducted air quality emissions inventories, modeled pollution impacts and work on air quality planning on a regional scale in and around the HLC NF area. There is a great deal of extensive and complex data available and this assessment only summarizes information relevant to the HLC NF forest plan revision.

Quantitative values for wildland fire smoke impacts are difficult to predict. Potential emissions from wildfires are difficult to predict as they would vary depending upon site-specific vegetation and fuels conditions, ignitions, weather, and available suppression resources. Emissions estimate models are available for estimating smoke emission from prescribe fire.

Fire and Fuel Management

Fire is a primary natural disturbance process within the HLC NF ecosystems that changes vegetation conditions. Fuels management consists of management activities designed to alter vegetation conditions to achieve desired results. Therefore, the analysis process for determining vegetation conditions, past, present and future provide the basis for the analysis of fire and fuels treatments within this section of the environmental impact statement. This process is briefly discussed below. Please refer to the Terrestrial Vegetation section for greater detail.

The vegetation management strategy for the HLC NF is to manage the landscape to maintain or trend towards vegetation desired condition. Modeling was used to estimate extent and effects of disturbance processes (such as fire) into the past (to develop a natural range of variation, or NRV) and into the future (to project future wildfire under a suppression scenario). Fire (planned and unplanned), insects (e.g., bark beetles), disease (e.g., root disease), weather events (drought, windthrow), and harvest treatments are the main drivers of vegetative change, interacting with climate and the process of vegetative succession. The main analytical models used were the SIMPPLLE model (SIMulating Patterns and Processes at Landscape scaLEs) (Chew, Moeller, & Stalling, 2012) and the Spectrum model (ERG, 2015).

Simulation modeling (SIMPPLLE) was used to estimate wildfire activity on the HLC NF for five decades into the future. Best available information was used to build the fire suppression logic and assumptions within the model, including corroboration with actual data, and professional experience and knowledge.

All alternatives contain objectives for treating (mechanical and wildland fire) vegetation to improve structure and composition, including reducing surface fuels, ladder fuels, and canopy density.

SIMPPLLE model results for future wildfire

The SIMPPLLE model is defined and discussed in the Terrestrial Vegetation section of this appendix; the results for projected wildfire acres burned are shown here. SIMPPLLE is used to estimate the probable extent and severity of wildfire in the future, taking into account expected climate, vegetation treatments, and fire suppression actions. The average acres projected do not imply an “even flow” of acres affected over time. The acres burned would vary by decade. These modeled estimates are based on best available information, but have a high level of uncertainty.

Figure 1. Mean acres per decade affected by wildfire, by alternative, across five decades

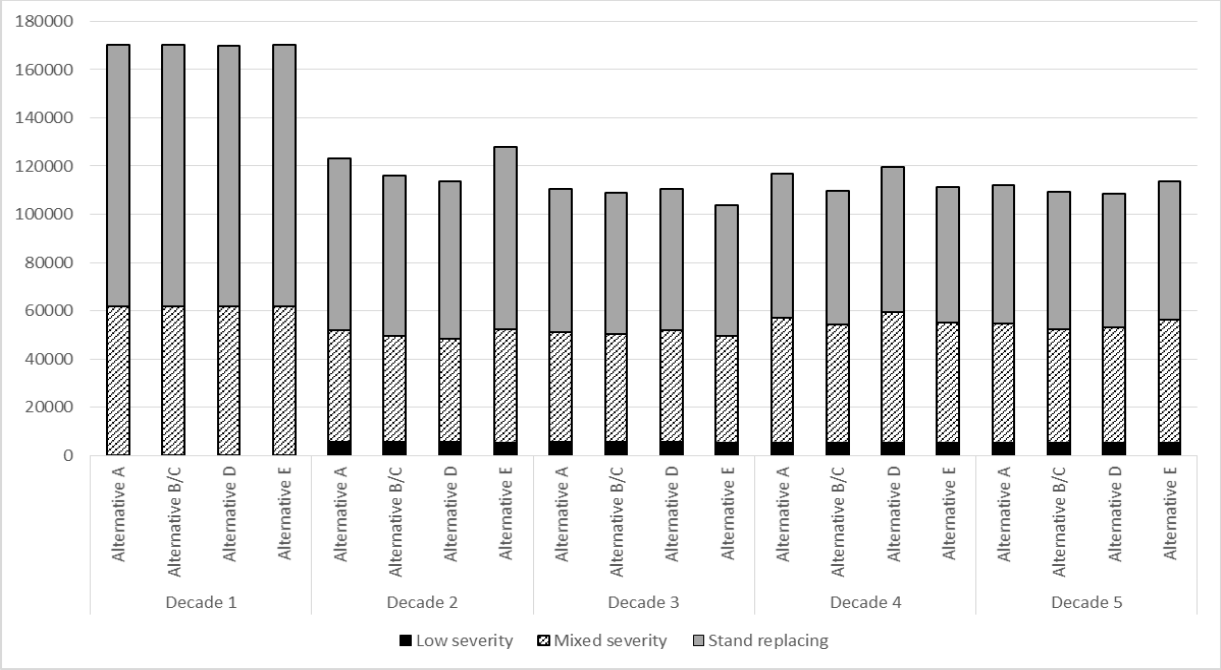


Figure 2. Mean acres per decade affected by low severity fire, by alternative

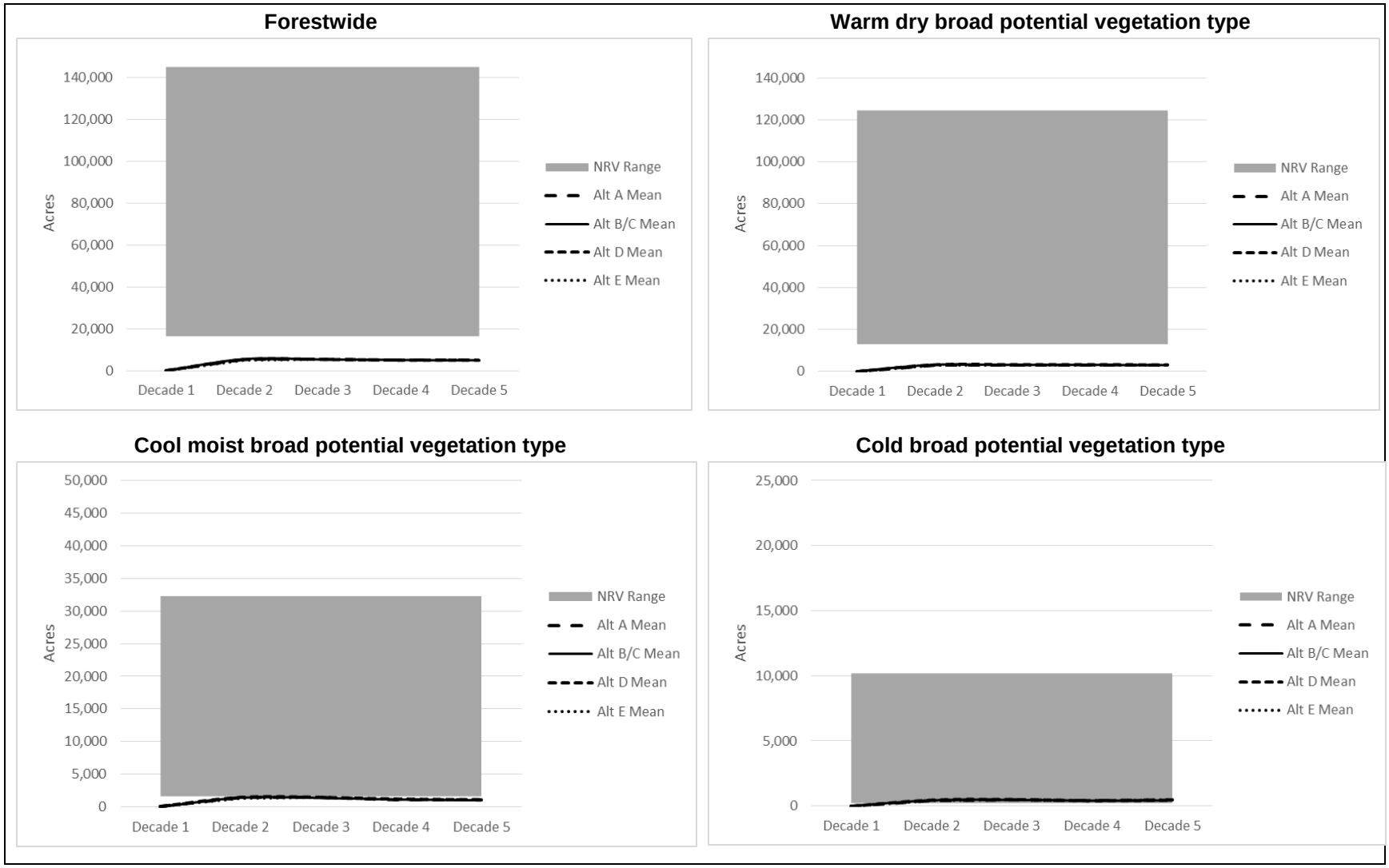


Figure 3. Mean acres per decade affected by mixed severity fire, by alternative

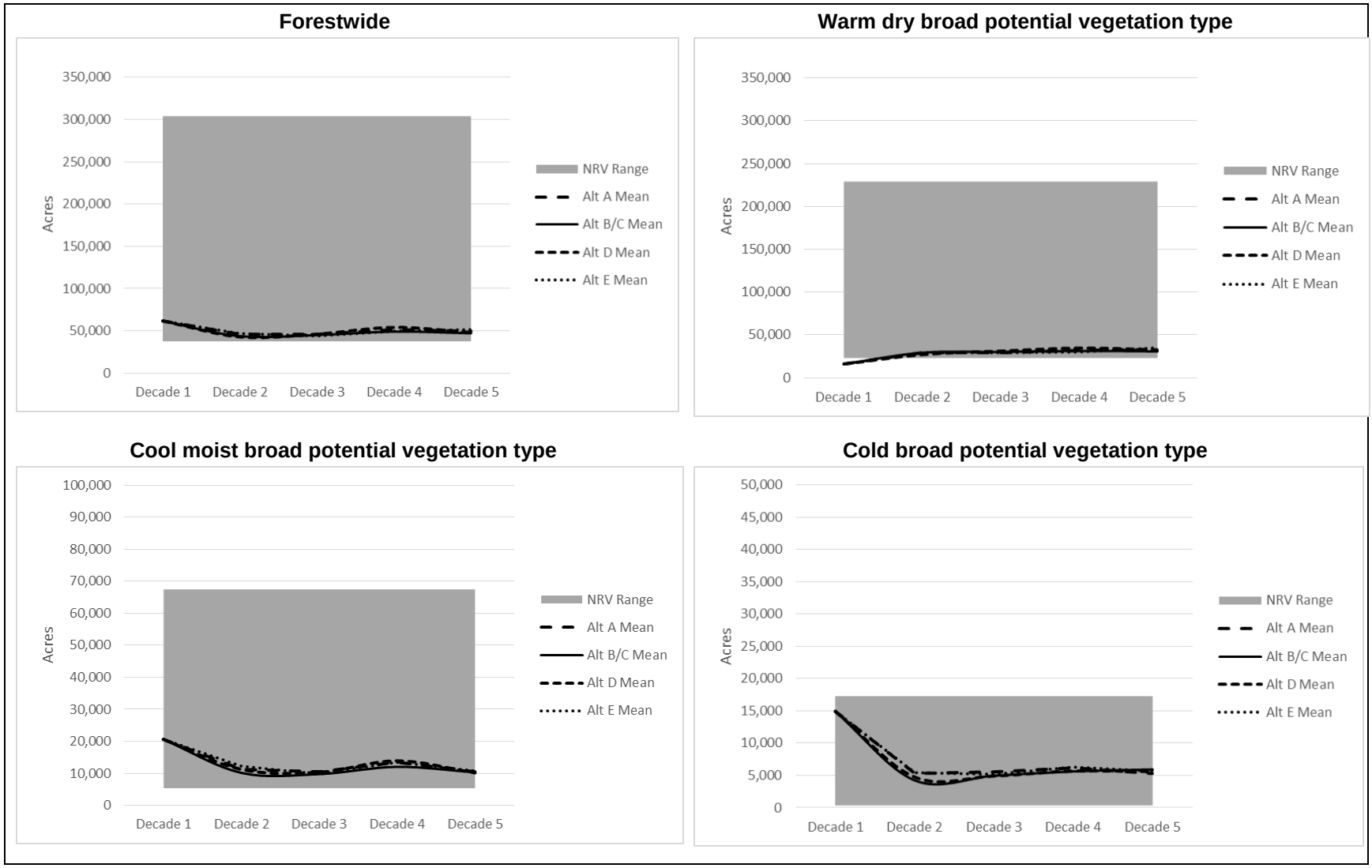
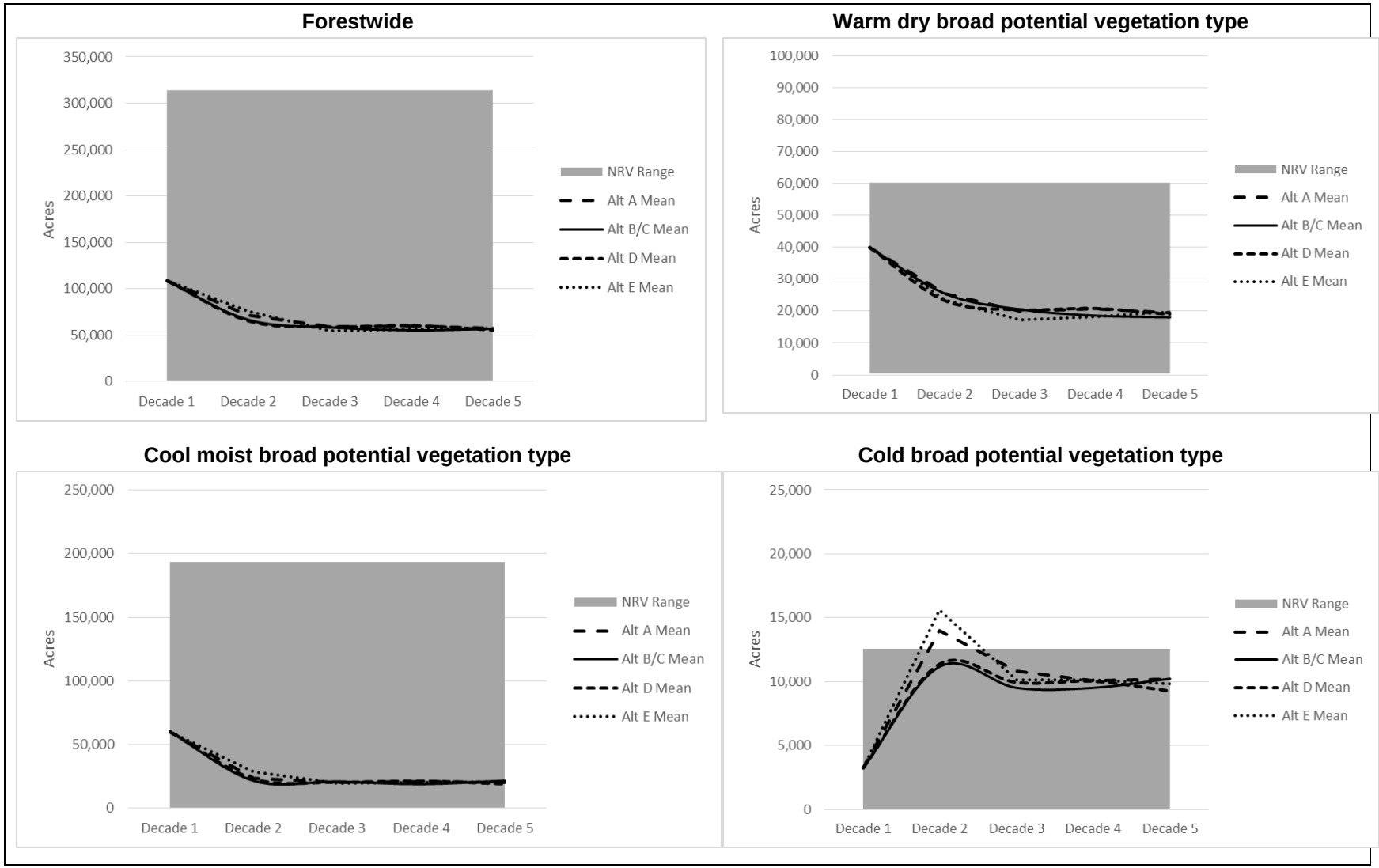


Figure 4. Average acres per decade affected by stand replacing fire, by alternative



Terrestrial Vegetation

Introduction

Biodiversity conservation focuses on the need to conserve dynamic, multi-scale ecological components, structures, and processes that sustain a full complement of native species and their supporting ecosystems. The terrestrial vegetation section documents the coarse filter analysis of the terrestrial ecosystems. Other sections focus on species-specific conditions and management strategies, or the "fine filter".

The affected area for terrestrial vegetation is the lands administered by the HLC NF. This area represents the NFS lands where changes may occur to vegetation as a result of management activities or natural events. Information is summarized at three scales:

1. Forestwide, to provide information on the broad scale context;

2. Broad potential vegetation group, because indicators vary by site capability;

3. Geographic area because the unique disturbance history and human uses of each area has and will continue to influence vegetation.

The affected area for cumulative effects also includes lands of other ownership within and immediately adjacent to the forest boundaries.

Data sources for vegetation analysis

A variety of well-researched and documented datasets and tools are used which collectively make up the best available science for quantifying vegetation. This determination is made based upon the following:

- Systematic field inventories using National and Regional field sampling protocols provide statistically based, consistent methodologies for quantifying vegetation characteristics and a high level of known accuracy. Forest Inventory and Analysis (FIA) plot data meets these criteria and are used to quantify the existing condition of vegetation.
- Vegetation mapping derived from National and Regional remote sensing protocols provide consistent methodologies for classifying and mapping vegetation characteristics, and are assessed for accuracy so that their level of uncertainty is quantifiable. This information is inherently less accurate and detailed than systematic plot sampling, but provides valuable complementary information and allows for an analysis of the spatial distribution of vegetation.
- Other databases and map sources are used where appropriate, with a clear understanding of their purpose, accuracy, and limitations. As needed, professional judgment and interpretation are provided to frame the information found in all data sources.

The analysis also draws upon the best available literature citations relevant to the ecosystems on the HLC NF. Sources that were the most recent; peer-reviewed; and local in scope or directly applicable to the local ecosystem were selected. Uncertainty is acknowledged and interpreted. Local studies and anecdotal information that are not peer-reviewed is included where appropriate. New studies and literature are continually becoming available, and may be incorporated throughout the forest plan revision process.

Forest Inventory and Analysis

Forest Inventory and Analysis (FIA) data comes from measurements taken at a set of points established on a nationwide systematic grid across all ownerships. The sample design and data collection methods are scientifically designed, publicly disclosed, and repeatable. These plots are systematic, spatially balanced, and statistically reliable for providing unbiased estimates of forest conditions for use at broad scales. A multitude of vegetation attributes are recorded, including but not limited to species, height, diameters, habitat type, age, physical defects, insect and disease, ground cover, fuel loading, understory species and

ground cover. Plots are re-measured on a 10 year cycle, meaning that 10% are re-read each year, allowing evaluation of trends in forest conditions over time.

FIA plots are used for many aspects of the analysis, including:

- estimate the existing condition;
- validate the reliability of spatial datasets and/or build logic to update those datasets;
- seed spatial datasets with the information required by vegetation models;
- provide the tree lists needed for yield table development

Forest Inventory and Analysis Base Grid

The FIA program maintains a national grid of plots that are referred to as the "base grid". The sample was designed to measure forested plots; non-forest plots are established but no data are recorded. Each plot represents about 5,000 acres. There are 150 base FIA plots on the Helena NF; 3 on the Beaverhead-Deerlodge NF portion of the Elkhorns; and 306 on the Lewis and Clark NF, resulting in 459 plots for the entire plan area.

Starting with annual plots collected in 2006, the Northern Region has contracted with the FIA program to collect the "All Condition Inventory" (Bush & Reyes, 2014). This inventory supplements the base plots by measuring plots and portions thereof that do not meet the definition of "forested". This effort is providing additional data for nonforested vegetation. At this time, only a subset of the base grid plots have information collected on non-forested plots.

The base grid is used to summarize conditions for the entire planning area, and to represent geographic areas (GAs) that do not have a grid intensification completed (described below). Many base grid plots have not been re-measured since the recent mountain pine beetle outbreak; the most recent plot measurement dates range from 1996 to 2011, with about half being measured prior to the outbreak beginning in 2006. Therefore, conclusions drawn from this data are supplemented by additional information. In addition, plots that have changed due to fire or harvest are excluded from estimates.

Forest Inventory Analysis Grid Intensification

To enhance analyses at multiple scales, the FIA base grid has been intensified by four times (4x) across the HLC NF. This dataset is designed to capitalize on the powerful statistical design of the base grid, and allows for more accurate estimates at smaller scales. The grid intensification uses data collection protocols established for the Northern Region that are compatible with national protocols (Bush & Reyes, 2014). This dataset is referred to as "intensified grid", or "4x grid". Plots are established across all national forest system lands, regardless of whether they are forested.

The initial installation of intensified plots began in 2006, and is complete for all GAs except the Rocky Mountain Range, as shown in Table 1. There are no plots on the portion of the Elkhorns GA that lies on the Beaverhead-Deerlodge NF. On GAs where the intensification is complete, 4x grid plots are added to base grid plots to create an analysis dataset that is used to summarize the GAs. Both datasets are reviewed to summarize the Elkhorns GA because the intensified grid covers the bulk of the area.

Table 1. FIA and FIA 4x Intensified grid sample status by geographic area, as of 2016

Geographic Area	Base FIA Plots	4x Grid Installation Date	4x Plots Installed	4x Plots Yet to Install	Total Plots Used for 4x Dataset	Plots with live/dead re-measurement	Plots with full re-measurement
Big Belts	49	2006-08	191	0	240	82 (2008-10)	78 (2016)
Castles	10	2010	44	0	54	35 (2012)	0
Crazies	10	2010	32	0	42	0	0
Divide	35	2007-08	145	0	180	96 (2012)	142 (2012-15)
Elkhorns	181	2006-07	72	0	87	24 (2009-10)	72 (2012)
Highwoods	7	2010	28	0	35	0	0
Little Belts	137	2009-10	588	0	725	365 (2012)	0
Rocky Mountain Range	1222	2012-Ongoing	297	217	368	0	0
Snowies	20	2010-14	81	0	101	0	0
Upper Blackfoot	51	2007-08	228	0	279	101 (2009-10)	156 (2014-15)
Total	**459**		**1,706**	**217**	**2,111**	**703**	**448**

1 Only 15 of the 18 base FIA plots in the Elkhorns are included in the 4x dataset because the remaining 3 lie on the Beaverhead-Deerlodge NF and are outside the 4x sample area. All 18 plots are included in the Hybrid 2011 dataset.
2 Only 71 of the 122 base FIA plots in the Rocky Mountain Range are included in the 4x dataset, because those plots are within the area where the 4x inventory is completed. The remaining 51 base FIA plots would be included when the 4x inventory is complete. All 122 plots are included in the Hybrid 2011 dataset.

Like the base grid, the intensified plots are on a 10-year re-measurement cycle. However, shortly after installation began the HLC NF experienced wide-spread mortality caused by mountain pine beetle which created a short term need for rapid re-measurements. Plots on western GAs that had at least 20 square feet basal area per acre of pine trees were re-visited to determine changes in status (live/dead). In addition, full re-measurements have been conducted according to the regular schedule, as shown in Table 1. The analysis datasets used to make estimates contain a "hybrid" of the most recent measurement of all plots.

The benefits of the intensified grid dataset include improved accuracy due to a large sample size; recent measurements reflect current conditions caused by the mountain pine beetle outbreak and some fires; and non-forested plot data. The primary weakness is that it is not complete on the Rocky Mountain Range GA. Plots are only installed on national forest system lands; therefore, the geographic extent of plots is less than the total administrative boundary area which includes inholdings of other ownerships.

R1 Summary Database and Estimator Tool

The R1 Summary Database is developed by the Northern Region Inventory and Analysis staff to summarize plot data (Bush & Reyes, 2014). The forest inventory analysis and intensified grid plots, described above, are summarized using this tool. Based on the measured data, a suite of standardized classification algorithms populate attributes of interest to the Northern Region (Barber, Bush, & Berglund, 2011; Bush & Reyes, 2014). The database structure includes:

- Oracle tables reside at a data center which warehouse summarized and attributed data based on inventory data residing in the database, FSVeg. The Oracle tables contain attributes collected at the site; derived attributes such as the R1 Existing Vegetation Classifications (Barber et al., 2011), R1 Wildlife habitat models, old growth; and associations to spatial datasets used for analysis.

- Access databases house a subset of the data in the Oracle Tables for a specified set of inventory data is called an *analysis dataset*. This database contains queries and reports that are built off of the Oracle Tables. The analysis datasets used for this DEIS include:
  a. F12_F15Partial_IntGrid_4x_Hybrid_2016COMBINED, which includes the latest measurements of the intensified grid plus base plots in areas with a completed intensified grid.
  b. R1 Hybrid 2011, which includes the most recent available measurements of base plots, and the sample covers the entire HLC NF plan area.
- The R1 Estimator Form is a stand-alone program that derives estimates and confidence intervals for data in the access database that is selected (Bush & Reyes, 2014). The form is a front-end application which allows users to derive estimates. Reports were generated which include the mean, standard error, and 90% confidence intervals. For all attributes other than potential vegetation, estimates were made excluding plots that had changed since fire or harvest. Potential vegetation is estimated including all plots, because fire or harvest would not change this attribute. All reports are available in the planning record.

Region 1 Vegetation Map (VMap)

The Region 1 Vegetation Map (VMap) is a spatially explicit map product that contains information about the extent, composition and structure of vegetation. Satellite and airborne acquired imagery is used, and refined through field sampling and verification. This geospatial dataset includes all watershed areas that intersect with national forest system lands on the HLC NF; private lands within these watersheds are included, so the map provides "wall to wall" coverage. The information is grouped into vegetation that is alike and organized into polygons. Each polygon has a life form, canopy cover, dominance type, and size class assigned consistent with the Region 1 Existing Vegetation Classification System (Barber et al., 2011). Additional information is attached using a digital elevation model (elevation, slope, and aspect); as well as continuous variables for tree size and canopy cover; probabilities of species occurrence; and additional attributes estimated by associating VMap classes to inventory plots.

The VMap was designed to allow consistent, continuous applications between regional inventory and map products across all land ownerships that is of sufficient accuracy and precision. VMap attributes have been assessed for accuracy through a process outlined for Region 1 (S. R. Brown, Jr, 2014; Vanderzanden, Brown, Ahl, & Barber, 2010). This accuracy assessment includes the results in Table 2 (S. R. Brown, Jr, 2014), which are within national mapping standards.

Table 2. Accuracy of VMap 2014 attributes for the HLC NF

Attribute	Accuracy
Lifeform	91%
Dominance Type (Dom40)	70%
Tree Canopy Cover	79%
Tree Size Class	69%

Potential Vegetation Mapping and Classification

Potential vegetation types (PVTs) are assemblages of habitat types, which are an aggregation of ecological sites of similar biophysical environments (such as climate, aspect, soil characteristics) that produce plant communities of similar composition, structure and function. The Northern Region has identified potential vegetation groups that are recommended for use at the broad levels to provide consistent analysis and monitoring, as described by Milburn and others (2015). These groups are used in the HLC NF revised forest plan. The three broad PVTs found in the plan area are warm dry, cool moist, and cold. The classification for each is provided in appendix D of the Draft Plan. PVTs provide the basis for development of desired conditions and other plan components.

R1 broad PVTs are included in the R1 Summary Database, based on field classified habitat type. For modeling, it was also necessary to map them. The PVT map used for this DEIS was developed by the Northern Region in the early 2000s (Jones, 2004). Sources of data included field plots and remote sensing. Lands with no field data were populated by extrapolation of plot data and the use of models that integrated site factors influencing vegetation, such as precipitation, slope and elevation. This layer, referred to as *R1 Potential Vegetation Types* or *R1-PVT*, is the best available PVT layer, although its level of accuracy is unknown. It is the only map of potential vegetation that covers the plan area, and is a mid-level depiction of ecological condition.

To have both potential vegetation and existing vegetation attributes applied to polygons for analysis, the R1-PVT map was joined to VMap. VMap polygons are the best delineations for vegetation; therefore, a single R1-PVT label was applied to each VMap polygon based on the majority type. Because R1-PVT is raster-based and the VMap is polygon-based, illogical combinations of potential vegetation and existing vegetation were inevitable. It was necessary to refine the attributes in a logical fashion to improve accuracy. An analysis was done to compare the R1-PVT to VMap as well FIA plots. Because it has a known level of accuracy and is based on the most current data available, VMap was assumed to be correct. Using this data, logic was written to correct illogical combinations between potential and existing vegetation; this logic is available in the project record.

HLC NF Geographic Information System (GIS)

The HLC NF has a library of geographic information system (GIS) data. The library includes a large number of mapped data layers, with associated metadata, including fire history, insect and disease surveys, grizzly bear habitat, lynx habitat layers, roads, topographical features, and administrative-related boundary layers (e.g., ownership, inventoried roadless areas, wilderness areas, wildland urban interface). Many summaries and assessments of vegetation condition were developed using GIS, which is both an analysis tool and a display technology. This tool was also used to map timber suitability; to build analysis units needed for Spectrum; and compile the spatial data used for the SIMPPLLE model.

Terrestrial vegetation desired conditions

Forest plan direction must provide for ecological integrity while contributing to social and economic sustainability (USDA, 2012). To achieve this, desired conditions have been developed for key vegetation components. Desired conditions describe, to the best of our ability, what would maintain ecosystem integrity while contributing to social and economic sustainability. Though the forest plan provides direction for a relatively short period of time (the next 15 years), desired conditions were developed with the long-term view in mind due to the long-lived nature of tree species. To address the uncertainty in future conditions, desired conditions incorporate strategies that would maintain or improve the resilience of the ecosystem and promote the adaptability of vegetation. The desired conditions incorporate the survival strategies trees and other plant species.

An analysis of the natural range of variation (NRV) was a primary element that informed desired conditions. The NRV provides a frame of reference for ecological integrity and resilience. It reflects the conditions that have sustained the current complement of wildlife and plant species, and provides context for understanding the natural diversity of vegetation and the processes that sustain it. Since the mid-1800s human presence and activities have increased dramatically in the plan area. NRV estimates provide a reference to conditions that might have occurred prior to these impacts. The intent of using the NRV to inform desired conditions is not to return to conditions that occurred at a single point in time, but rather to understand the full range of conditions that were supported prior to substantial human influence.

The future will not be the same as the past. The NRV does not provide insight into conditions that may vary in the future, or other considerations relative to social demands placed on the ecosystem. Further, the analysis includes inherent uncertainty and it is appropriate to utilize additional resources, including

literature, to ensure the "envelope" of vegetation conditions described by desired conditions will meet future ecological and social needs. Therefore, the desired conditions are not always equal to the natural range of variation, and additional factors were considered in the development of desired conditions.

The directives (2015) recognize there may be other factors (social, economic or ecological) that lead the responsible official to determine that the NRV may not be an appropriate desired condition for certain characteristics. These considerations include maintaining conditions that contribute to long-term resilience given uncertainties in future climate and disturbances; sustaining stand structures or species compositions that provide habitat for at-risk wildlife or plant species; conserving rare structures or components; existing or anticipated human use patterns; the effects changing climate may have; and ecosystem services expected from forest lands (such as reduction of fire hazard and production of forest products).

Research has been done that indicates there is potential for ecological transformations to occur in temperate ecosystems, based on the potential for interrelated drivers such as chronic and acute drought, wildfire, and insect outbreaks to push ecosystems beyond their thresholds for resilience (Golladay et al., 2016; Millar & Stephenson, 2015). In some cases management intervention might be able to ease the transition to new forest states and minimize losses of ecosystem services (Millar & Stephenson, 2015). We do not currently have the capability to predict such possible shifts at the local scale. By basing the desired conditions around the full range of natural variation, with a focus on maintaining the full suite of ecosystem diversity and components that enhance resilience to disturbance, the Draft Plan would guide management toward maintaining functioning ecosystems in the face of uncertainty.

Natural range of variation (NRV) analysis

The SIMPPLLE model was used to estimate the NRV, which is the variation of ecological characteristics and processes over scales of time and space that are appropriate for a given management application. This concept is used as a tool for assessing ecological integrity. The NRV is displayed as a range of a given condition (minimum and maximum) in proportion of area forestwide, by broad PVT, and by GA. The primary attributes modeled included vegetation composition, size class, density class, and vertical structure class. The natural extent and severity of disturbances such as wildfire and insect outbreaks was also provided, as well as an analysis of the natural size of early successional forest openings. The results of this analysis provided the basis for the development of desired conditions.

When considering the period of time over which to evaluate the natural range of variation, "the pre-European influenced reference period considered should be sufficiently long, often several centuries…and should…include short-term variation and cycles in climate" (USDA, 2015). To meet this intent, vegetation conditions 1,000 years into the past were modeled. This reference period allowed the HLC NF to simulate the conditions associated with much of the time period known as the Medieval Climate Anomaly (about 950 to 1250), as well as the other end of the climate spectrum known as the Little Ice Age (early 1300s to about 1870s). The inclusion of the Medieval Climate Anomaly is valuable in that it might indicate conditions and processes that could occur in the modern climate regime. SIMPPLLE was run under a scenario that included natural ecological processes and disturbances, and their interaction with climate, using the Palmer Drought Severity Index as the indicator of past climate. Data for this index is reconstructed for localized points, and the data point nearest the HLC NF was used to evaluate the climate. The data was categorized into three climate scenarios: wetter, dryer, and normal, and the appropriate scenario was applied to each modeling period (decade). Key model processes, such as wildfire, insects, and disease function differently depending on the climate scenario. Thirty simulations were run to capture the variability and uncertainties associated with potential disturbances.

The SIMPPLLE model is also used to project vegetation change into the future, as affected by anticipated treatments, natural disturbances and climate change. These results can be compared to the natural range of variation and the desired conditions to evaluate relative differences between alternatives.

Desired conditions for vegetation key ecosystem characteristics

This section describes the relationship between the existing condition and the desired condition range for all key ecosystem characteristics that were included in the terrestrial vegetation analysis. The source of the data for the current condition is FIA data and intensified grid data expressed as an estimated mean percent, with a lower and upper bound estimate provided at a 90% confidence interval.

Species composition: cover types and tree species presence

The exclusion of fire since modern settlement has resulted in a higher proportion of late seral, shade tolerant species at the expense of shade-intolerant types. This is most evident in the warm dry broad PVT and in cover types where high frequency, low severity fires would have been common. Low elevation, dry forests have experienced the greatest magnitude of change in composition, structure and function because of fire suppression, forest management, and climate change (Hessburg & Agee, 2003; Hessburg, Agee, & Franklin, 2005; Westerling, Hidalgo, Cayan, & Swetnam, 2006). Still, even cover types adapted to long fire return intervals and stand-replacing severities such as lodgepole pine have changed because these forests also burned in low-to mixed-severity events historically which created variable age structures and patterns (Kashian, Turner, Romme, & Lorimer, 2005). Table 3 describes the desired trend for composition.

Table 3. Desired trend of composition by R1 broad PVT

Broad PVT	Desired trend of cover types	Desired trend of tree species distribution
Warm Dry	The most substantial gap between existing and desired condition for cover type exists in this group. There is less of the ponderosa pine cover type (which includes limber pine dominance types) than desired, and more Douglas-fir dominated types. Changing these proportions would provide habitat for wildlife and forests resilient to fire and drought. Other cover types such as Engelmann spruce, lodgepole pine, and aspen are desired where moisture is less limiting. Desired conditions would promote complex landscape patterns and large trees beneficial for wildlife, timber production, and seed sources. Open forest savannas should occur on the hottest, driest sites dominated by grass or shrubs with widely scattered trees (5 to 10% canopy cover). These areas blend into grass and shrublands and may be more prevalent in the future.	The distribution of limber pine, aspen, and ponderosa pine are below the desired condition, and Engelmann spruce is above. Increases in ponderosa, limber, and aspen will be supported by future warm climate and fire. Ponderosa pine is highly drought tolerant and when stressed is generally less susceptible than Douglas-fir to pathogens. Douglas-fir is likely to experience greater stress with drying conditions.
Cool Moist	An increase in the lodgepole pine cover type is desired, with a decrease in mixed mesic conifer (dominated by Douglas-fir). The desired condition would favor lodgepole pine and whitebark pine over Douglas-fir and Engelmann spruce given expected climate and wildfire. All cover types suited to these sites, especially aspen, should be present to achieve diversity at multiple scales. Desired conditions would sustain multistory lynx habitat in spruce/fir cover types and provide the habitat diversity necessary for other wildlife species, and stand conditions more resilient to future disturbance and climate change. The western larch cover type is limited within its natural range to the Upper Blackfoot GA.	Distribution of Douglas-fir, Engelmann spruce, and subalpine fir are all above the desired range, while lodgepole pine and aspen are slightly below. Increases in lodgepole and aspen are desired. Infrequent, large fires characteristic of this setting will favor these species over those with low fire resistance.
Cold	Desired conditions are to increase the whitebark pine cover type, focusing on sites best suited (e.g. open ridges and harsher aspects). On sites where whitebark pine is	Whitebark pine distribution is much lower than desired, and should increase with a decrease

Broad PVT	Desired trend of cover types	Desired trend of tree species distribution
	capable of surviving, there should be a decrease in subalpine fir, and to a lesser extent Engelmann spruce. Subalpine fir may be the most common species and dominate northerly and easterly aspects, swales, moist basins, and riparian areas. Some lodgepole pine cover types are desired, mainly on warmer sites, for species diversity and responses to fire.	in subalpine fir and spruce. Lodgepole pine is also above the desired range and should be limited to warmer sites.
Nonforested	The desired condition is to maintain or increase the extent of nonforested plant communities, primarily grass, shrub, and riparian grasses/shrubs. Nonforested cover types will be promoted with future warm and dry climate. Although modeling is limited for these types, the subsequent section provides more description of the existing and desired conditions for non-forested potential vegetation groups, cover types, and specific species.	It is desirable to limit the encroachment of coniferous tree species onto nonforested potential vegetation types.

The following figures display the current condition and desired range of proportions of cover types and tree species presence forestwide and by each broad PVT. Tree species presence is also analyzed at the GA scale. The plot data (existing condition) includes cover types labeled as "none", which include both nonforested types as well as forested types that were recently disturbed and have not yet reforested.

Figure 5. Cover type current and desired condition, forestwide

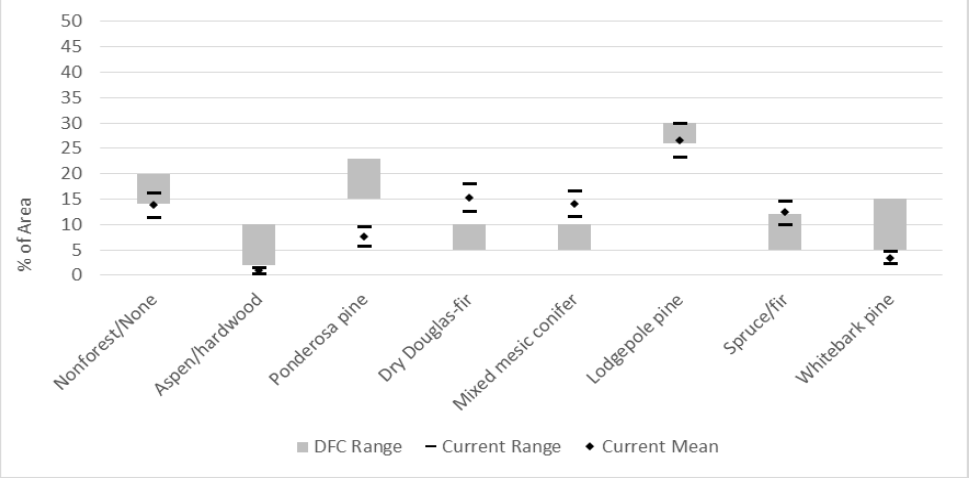


Figure 6. Cover type current and desired condition, warm dry broad PVT

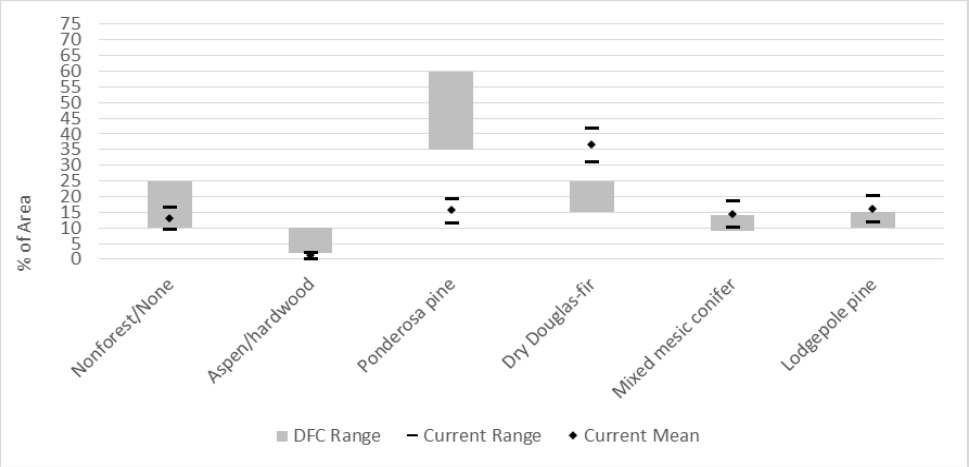


Figure 7. Cover type current and desired condition, cool moist broad PVT

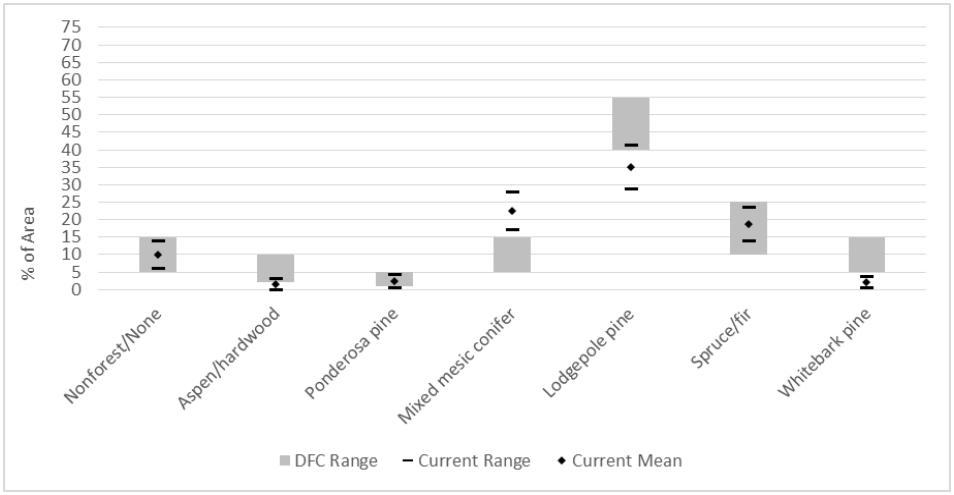


Figure 8. Cover type current and desired condition, cold broad PVT

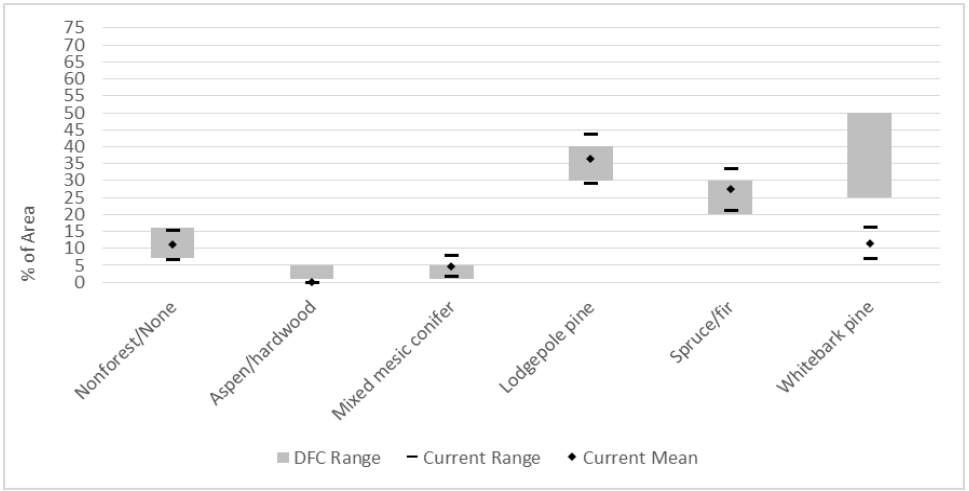


Figure 9. Current and desired condition for nonforested cover types by GA

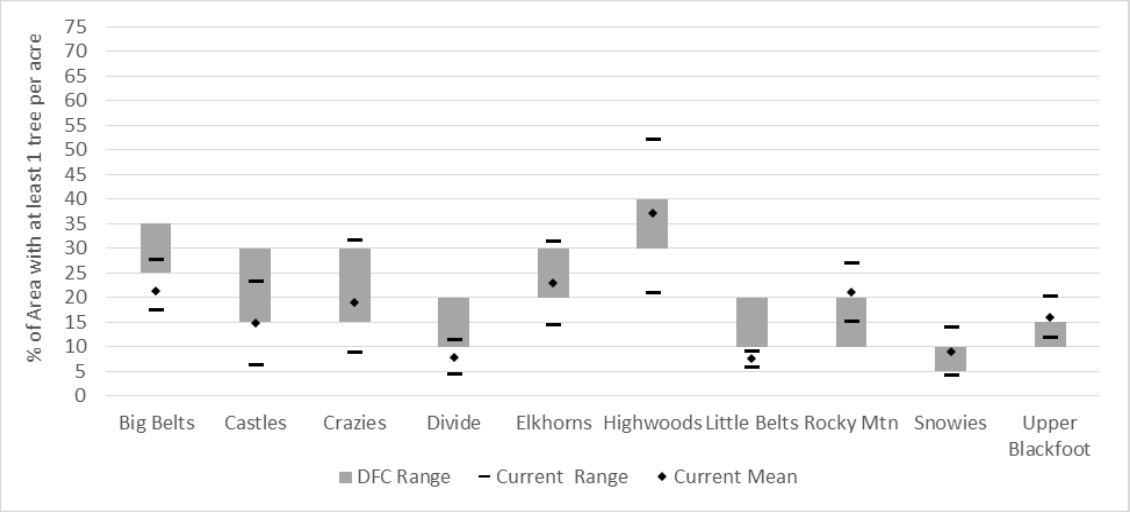


Figure 10. Tree species presence current and desired condition, forestwide

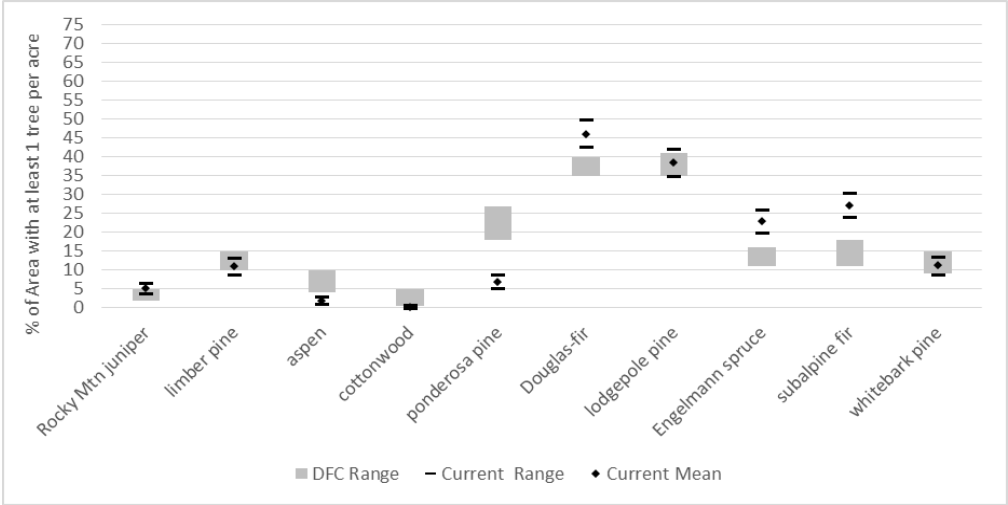


Figure 11. Tree species presence current and desired condition, warm dry broad PVT

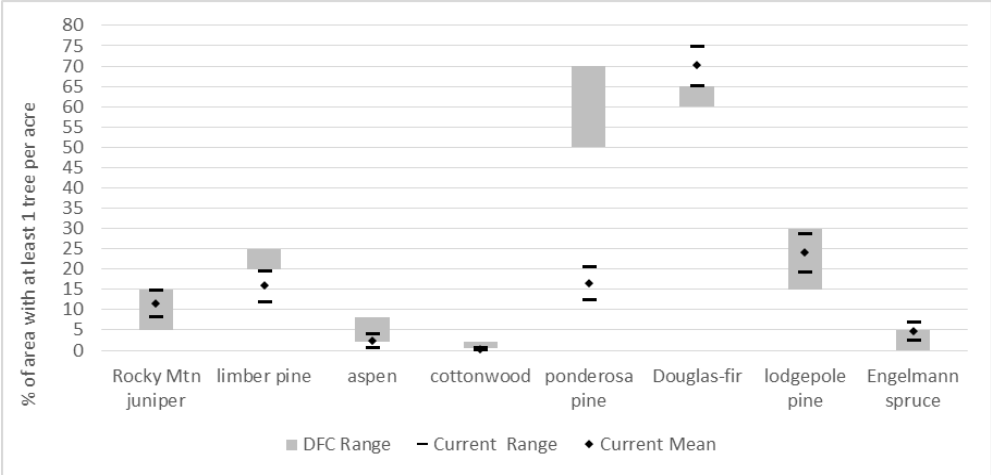


Figure 12. Tree species presence current and desired condition, cool moist broad PVT

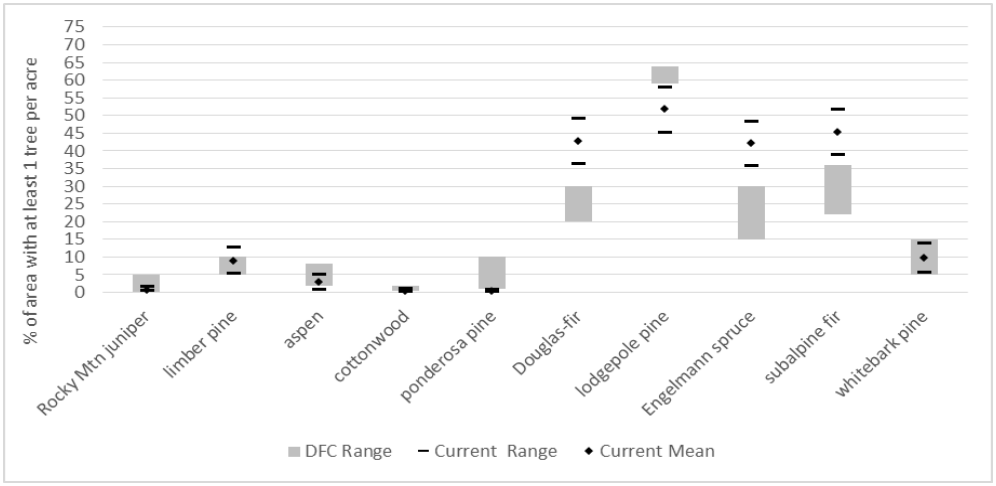


Figure 13. Tree species presence current and desired condition, cold broad PVT

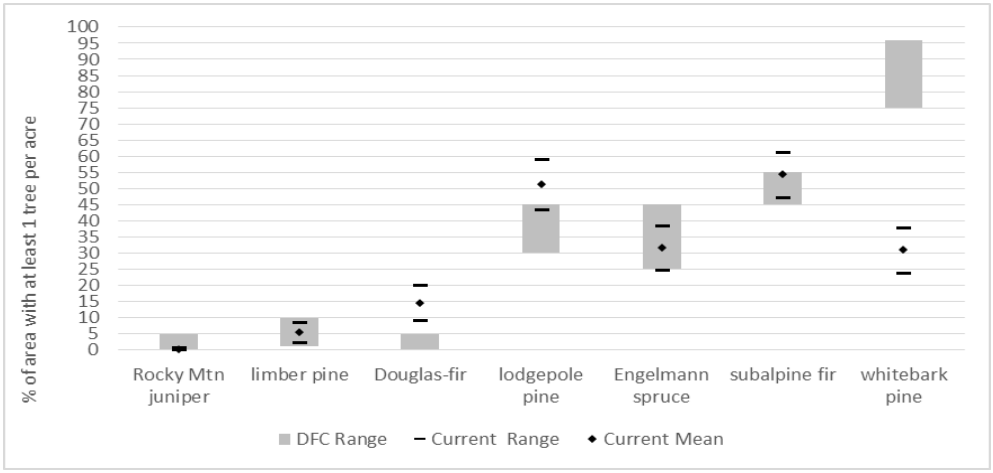


Figure 14. Current and desired condition for limber pine presence by GA

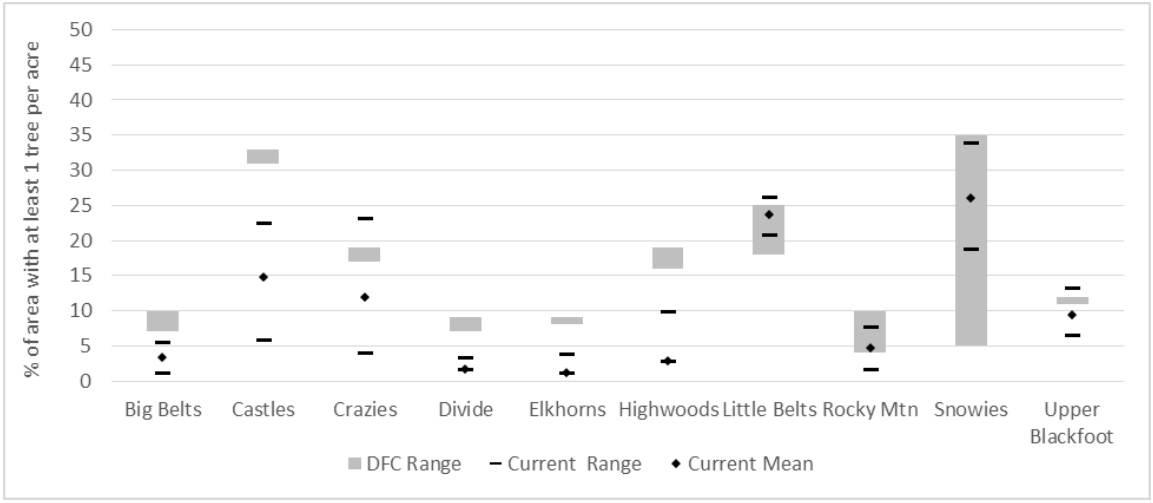


Figure 15. Current and desired condition for Rocky Mountain juniper presence by GA

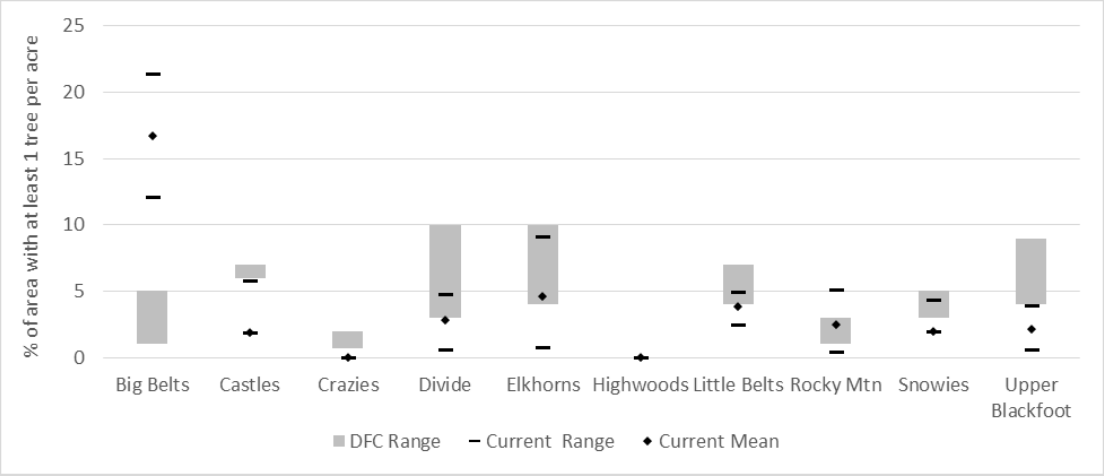


Figure 16. Current and desired condition for ponderosa pine presence by GA

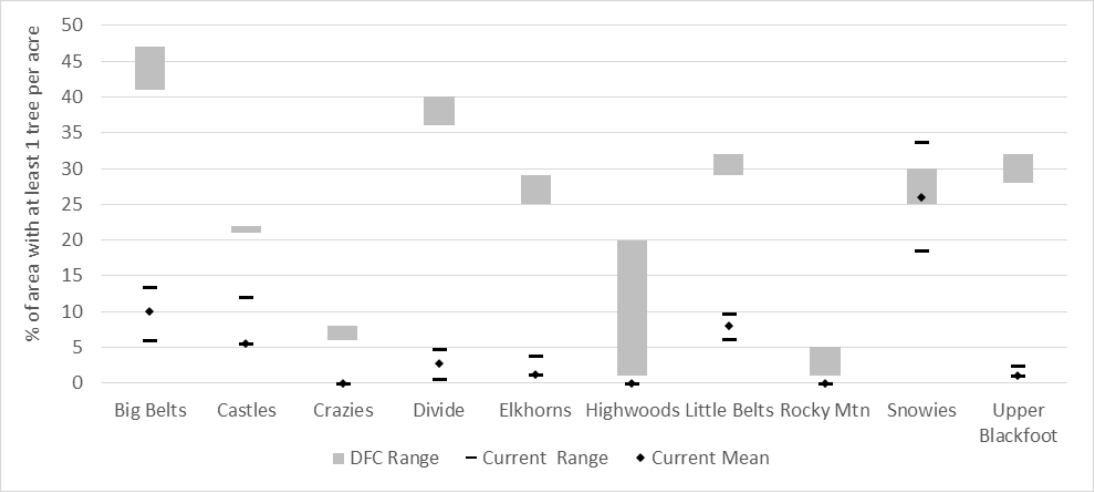


Figure 17. Current and desired condition for Douglas-fir presence by GA

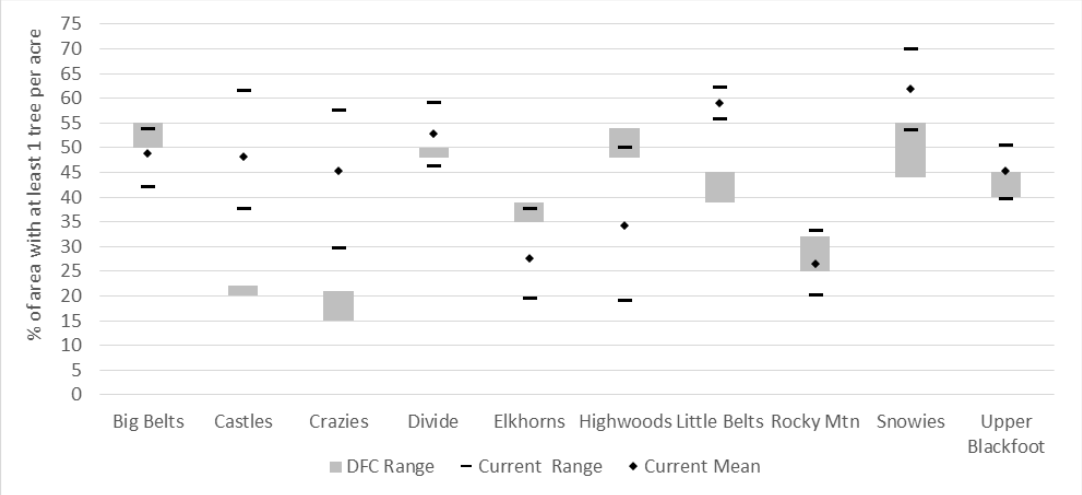


Figure 18. Current and desired condition for aspen presence by GA

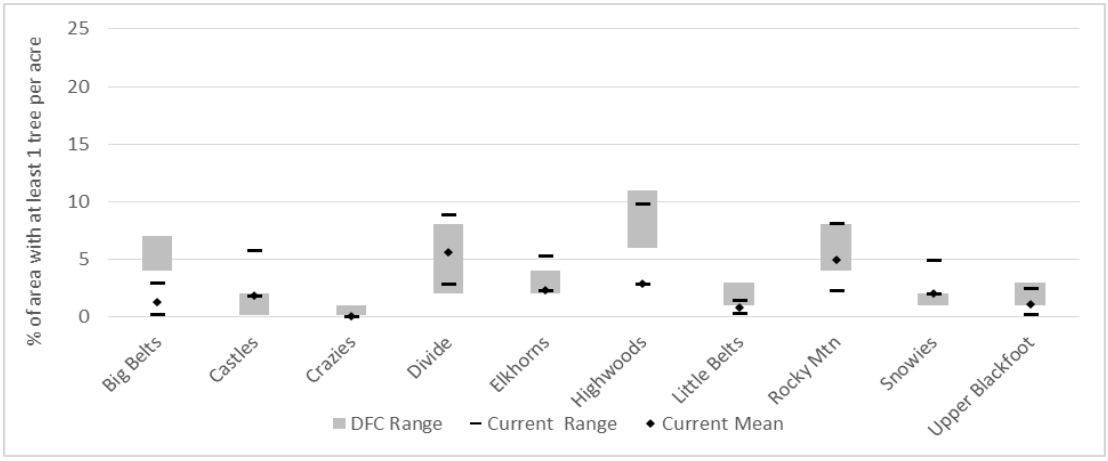


Figure 19. Current and desired condition for lodgepole pine presence by GA

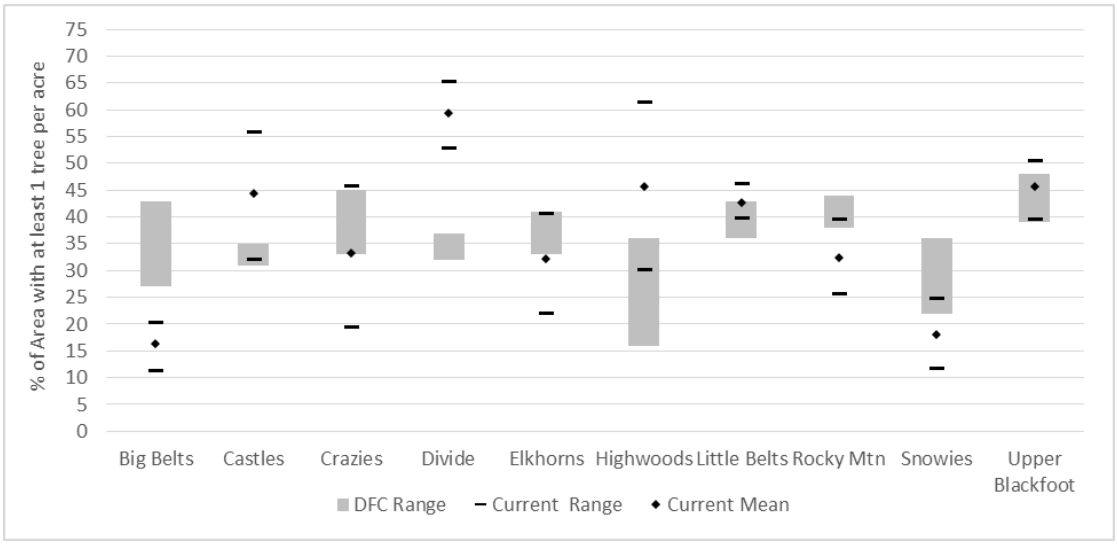


Figure 20. Current and desired condition for Engelmann spruce presence by GA

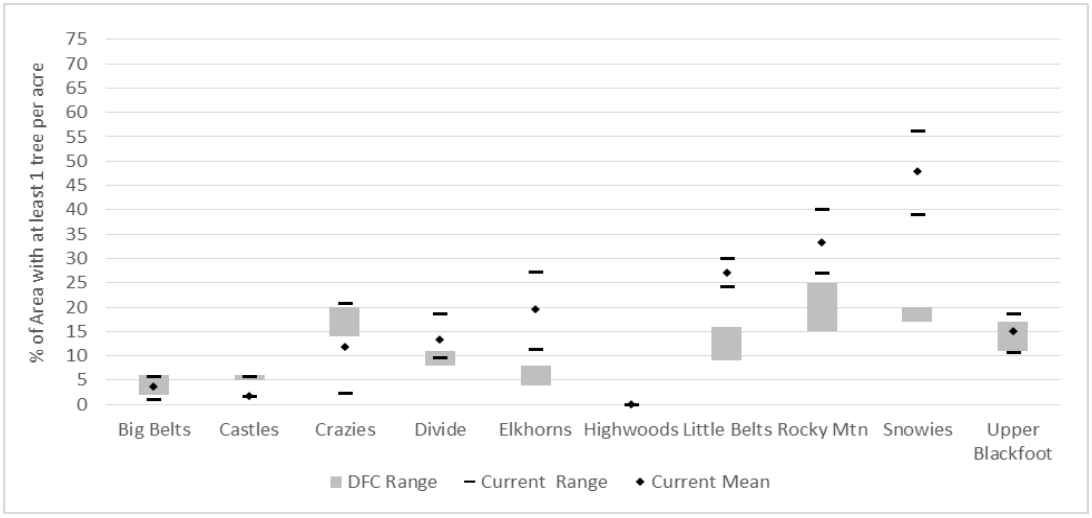


Figure 21. Current and desired condition for subalpine fir presence by GA

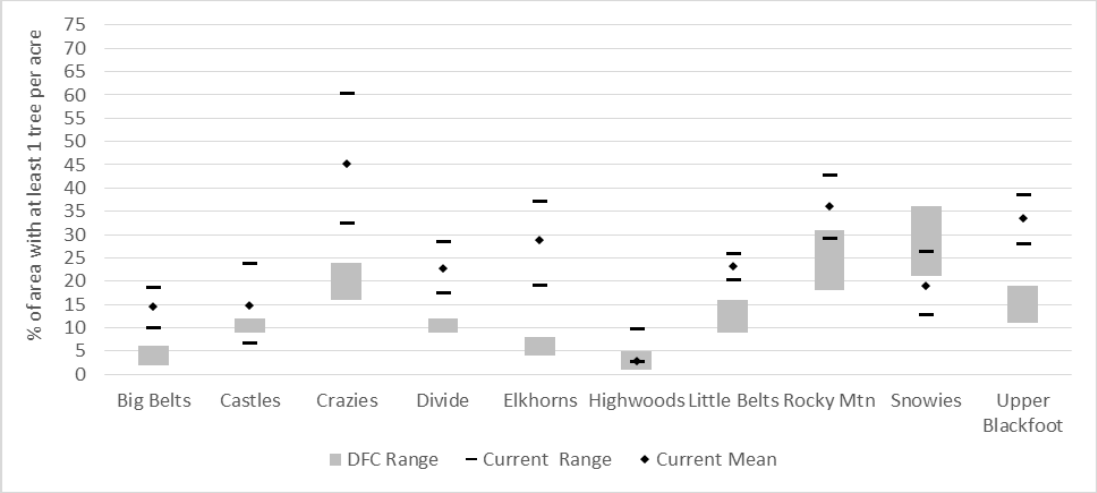
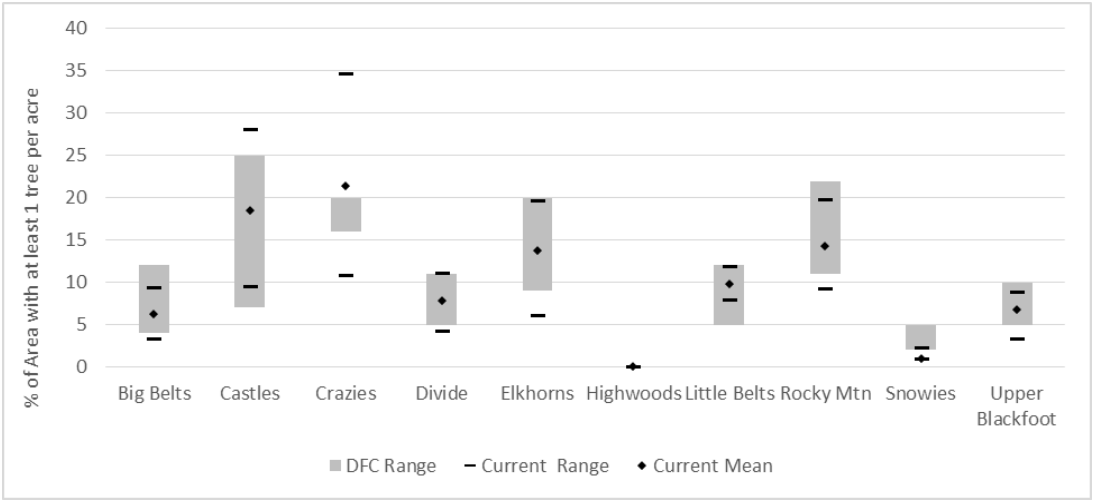


Figure 22. Current and desired condition for whitebark pine presence by GA



Forest size class

The primary desired shift in size class is an increase in the large size class and a decrease in the small size class. Modeling indicates that large and very large size classes were at the lower end of their natural ranges of variation during warm/dry periods such as those expected in the future; however, this level still exceeds the existing condition. A wide range of seedling/sapling forests is desired because this class fluctuates according to the size and frequency of stand replacing disturbances. Substantial proportions of the forest should be in the mid-successional stages of development (small to medium size classes), where they can remain for long time periods. Less dense forests or forests on more productive sites may transition up to large size class relatively quickly (e.g., 100 years from fire event), while higher density forests or those on harsh growing sites may take much longer. Some forest types (such as lodgepole pine) may remain in the small and medium classes their entire lifespan. A limited amount of the very large forest size class is possible based on the species and growing conditions found on the HLC NF. Many forest stands will never achieve a very large size class, due to growing conditions and/or disturbances. The table below describes the desired trend for forest size class by broad PVT.

Table 4. Desired trend of forest size class by broad PVT

Broad PVT	Desired trend of forest size class
Warm Dry	The existing proportion of small and medium size classes are well above the natural range of variation and desired condition, while the large class is substantially below. The very large class is also underrepresented. Large and very large sizes forests would have been relatively open or clumpy patch mosaics, with the large trees generally being long-lived species capable of surviving moderate or low severity fire when mature (for example ponderosa pine and Douglas-fir). In sheltered riparian areas, groves of large Engelmann spruce could develop. The warm dry group is the most substantially departed from the natural range of variation, congruent with our understanding of the effects of fire exclusion in these types. The desired condition reflects a fire regime characterized by more frequent low to mixed severity fires, with all forest size classes relatively well represented.
Cool Moist	The abundance of the small tree class is only slightly above the natural range of variation and desired condition. The existing proportion of large and very large size classes are somewhat below the desired range but not to the extent as warm dry sites. In large part, this is due to this potential vegetation group being dominated by lodgepole pine, which naturally does not reach large sizes. In areas with large size classes, a fire tolerant large diameter overstory tree layer would typically exist (Douglas-fir) atop a more dense mid and understory tree layer. Large, old Engelmann spruce and subalpine fir could occur in sheltered, moist settings.
Cold	The existing proportion of the small tree size class is above the desired range, and the large tree size class is below. Unlike the other potential vegetation groups, the very large tree class is within the natural range of variation, likely because the harsh conditions and species present on these sites make the achievement of a very large size difficult. Whitebark pine was historically the large tree component, tolerant of the moderate or low severity fires that typically occurred. Large subalpine fir and Engelmann spruce would develop in riparian areas and moist basins.

The following series of figures display the current condition and desired range in proportion of size classes forestwide and by each broad PVT.

Figure 23. Forest size class current and desired conditions, forestwide.

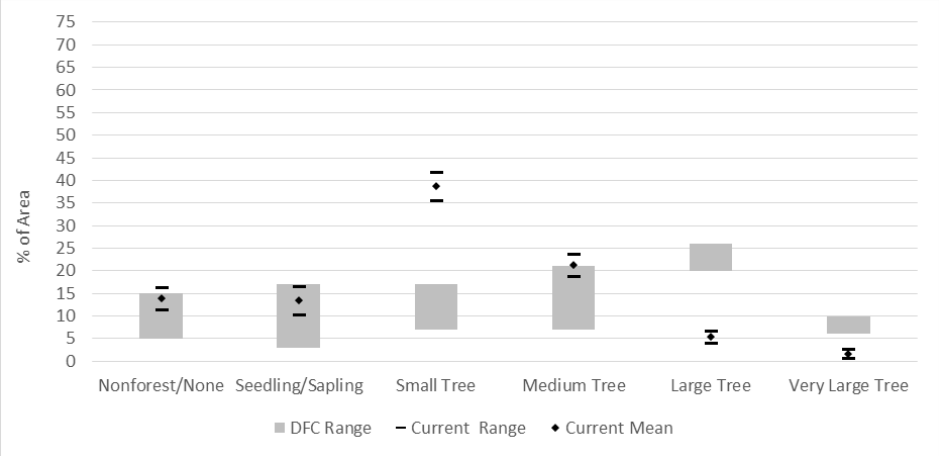


Figure 24. Forest size class current and desired conditions, warm dry broad PVT

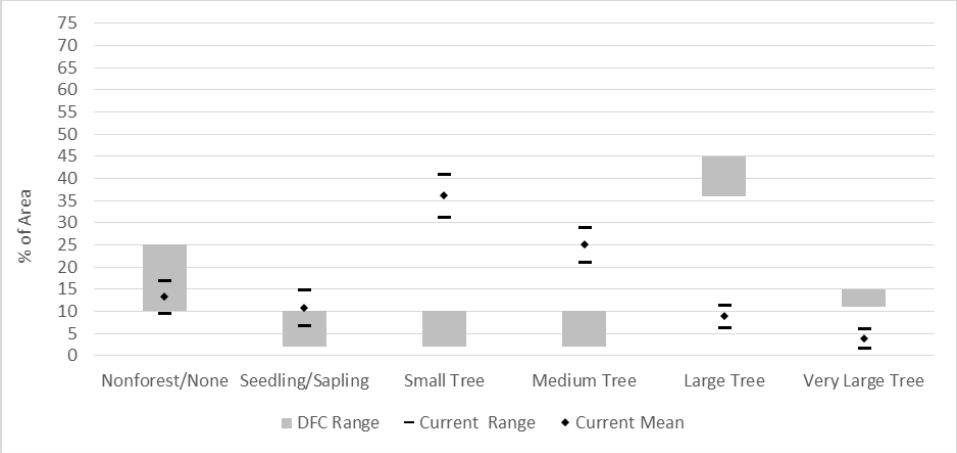


Figure 25. Forest size class current and desired conditions, cool moist broad PVT

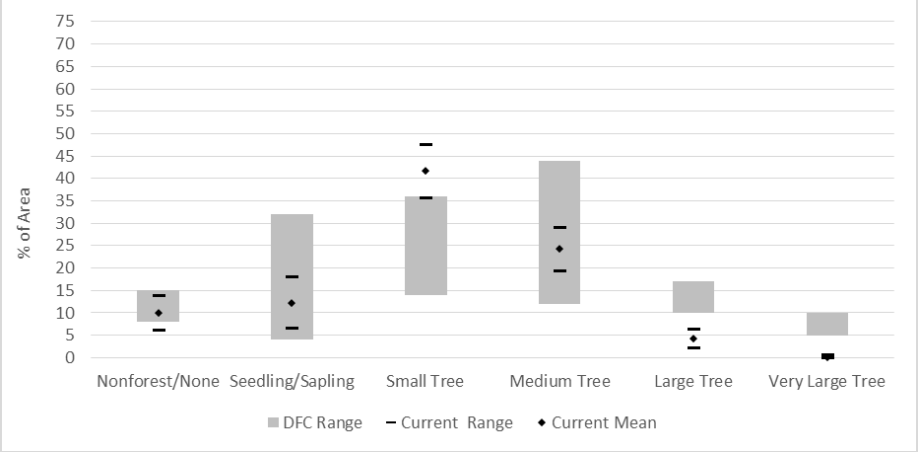
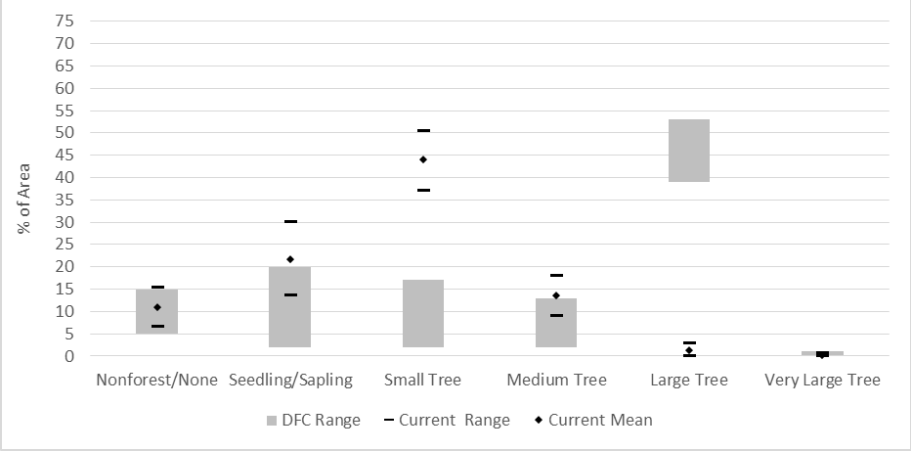


Figure 26. Forest size class current and desired conditions, cold broad PVT



Large and very large live tree concentrations

While the proportion of very large tree concentrations across the landscape are slightly lower than desired, the large tree concentrations are much more so, especially in the warm dry and cold broad PVTs.

Figure 27. Current and desired condition for large tree concentrations forestwide and by broad PVT

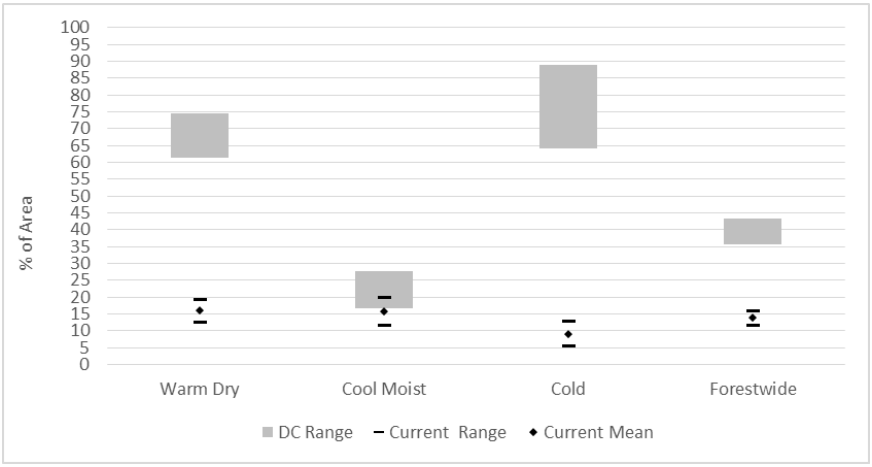
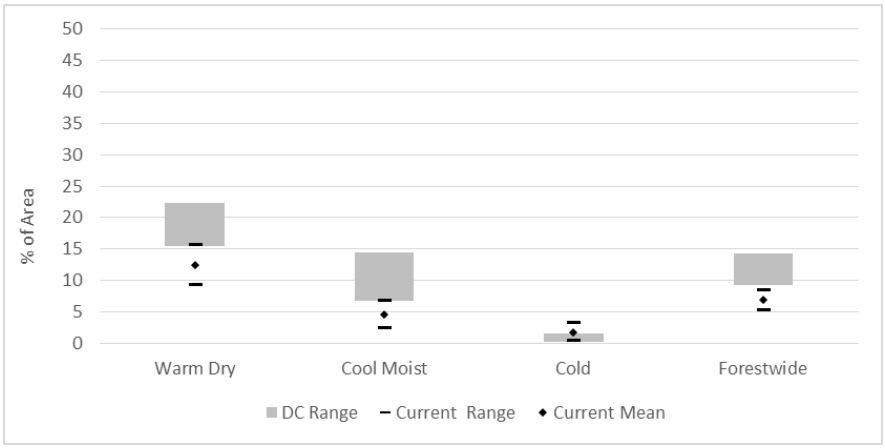


Figure 28. Current and desired condition for very large tree concentrations forestwide and by broad PVT



Large and very large live trees per acre

The final indicator for large and very large trees is the average trees per acre. These trees may be clumped or scattered, rare individuals that are not captured in either the size class or concentration criteria. It is desirable to maintain or increase the area and/or density of the large and very large live trees however they are distributed. Due to their longevity, fire resistance, and contribution to ecosystem resilience, the most desired species of these are Douglas-fir and ponderosa pine.

The following figures display the current condition and desired range of large and very large trees per acre forestwide and by snag analysis groups as defined by Bollenbacher and others (2008). Snag analysis groups are appropriate because they split apart lodgepole pine dominated areas. This provides a more accurate depiction of the ability of sites to produce large and very large live trees. Lodgepole pine is smaller in size and shorter lived than the other tree species.

Figure 29. Current and desired condition for large trees per acre forestwide and by snag analysis group

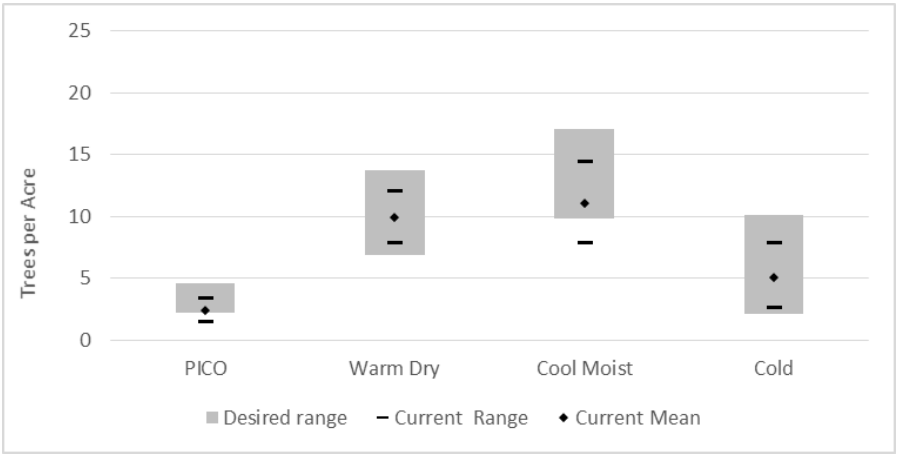
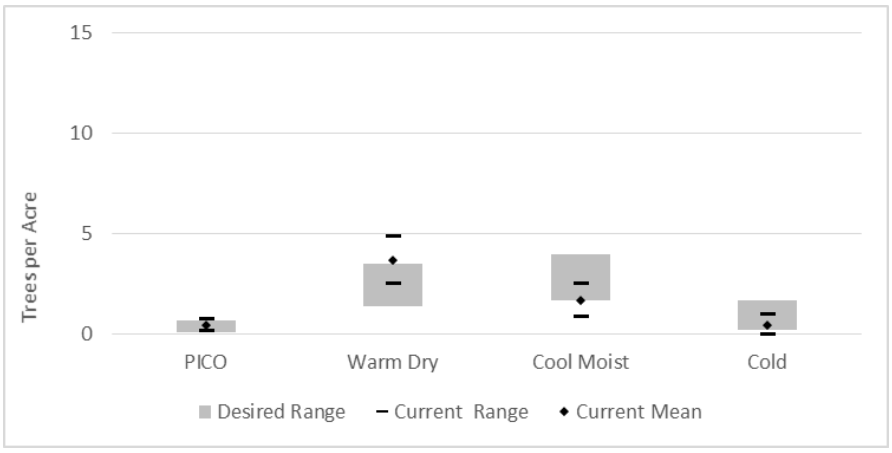


Figure 30. Current and desired condition for very large trees per acre forestwide and by snag analysis group



Forest density and vertical structure class

The NRV analysis indicated that the low/medium canopy cover class was common forestwide, especially on the warm dry broad PVT. Fire exclusion has resulted in higher canopy densities in dry cover types which would otherwise have been maintained at more open densities by frequent low intensity fire. Many forests on the cool moist PVT also had low/medium density, which were likely forests in their early and mid-successional stages or older forests where disturbances removed trees and opened up the canopy. In all types, the shift toward higher densities reflects the impacts of fire exclusion and the increased abundance of shade tolerant species. Low/medium density forests were at the higher end of their natural ranges during warm/dry periods, whereas medium/high and high density forests were at the lowest end. In pine dominated forests, the mountain pine beetle outbreak may have recently caused changes in the forestwide averages. It is likely that some of high density pine areas have shifted into open classes. The table below displays the desired conditions for density classes and associated vertical structures.

Table 5. Desired condition for forest density and vertical structure

Broad PVT	Desired condition of density class and vertical structure
Warm Dry	These sites historically supported more open forests than what is present today. It is desirable to increase the proportion of low/medium and reduce the high density class.

Broad PVT	Desired condition of density class and vertical structure
	A variety of structure classes would be appropriate depending on the site. Single-storied forests are common, but in some cases may represent forests where low severity disturbance has not opened up the canopy to allow for understory trees to establish in a widely spaced distribution. Promoting multi-storied, yet open, forests would be desirable in some of these areas.
Cool Moist	The medium/high density class is lower than the desired range and the high density class is higher. This may be indicative of dense understories of shade tolerant trees developing under lodgepole pine canopies in the absence of fire, and/or with the release of these components due to mountain pine beetle infestation. A single storied condition is naturally abundant, reflecting the traits of the most common species present, lodgepole pine. Multi-storied forests are also important, and are likely most often found in spruce/fir cover types.
Cold	The desired trend is similar to the warm dry broad potential vegetation group. In the past, fire promoted more open and uneven-aged whitebark pine forests. Single storied forests are likely dominated by lodgepole pine or whitebark pine, while spruce and fir would grow in a multistoried condition. Single-storied forests are at the high end of their natural abundance during warm/dry periods while two and multi-storied conditions are at the low end. A focus on increased resiliency through decreased density is important. The overabundance of high density forests may reflect the shift from whitebark pine to spruce and fir in many areas with fire exclusion and due to the other threats facing whitebark pine such as mountain pine beetle and white pine blister rust.
Nonforested	Based on the modeling, it would initially appear that non-forested or savanna areas may be more prevalent today than historically; however, these types were more abundant during warm/dry climate periods. Therefore, a trend of maintaining or increasing non-forested types – and very low tree cover <10% on some forested types – is appropriate for the future desired condition. In one local example, this conclusion was demonstrated by a study in the Elkhorns GA which found that there has been a three-fold increase in the amount of closed-canopy forest at the expense of grass, shrub, and open tree stands compared to historical conditions (Barrett 2005).

The following figures display the current and desired proportions of density classes forestwide and by broad PVT.

Figure 31. Current and desired percent of area by forest density class, forestwide

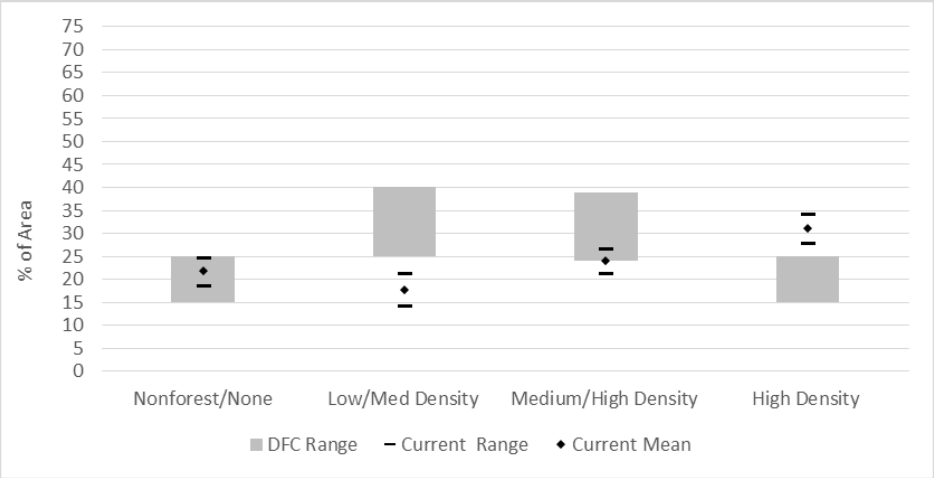


Figure 32. Current and desired percent of area by forest density class, warm dry broad PVT

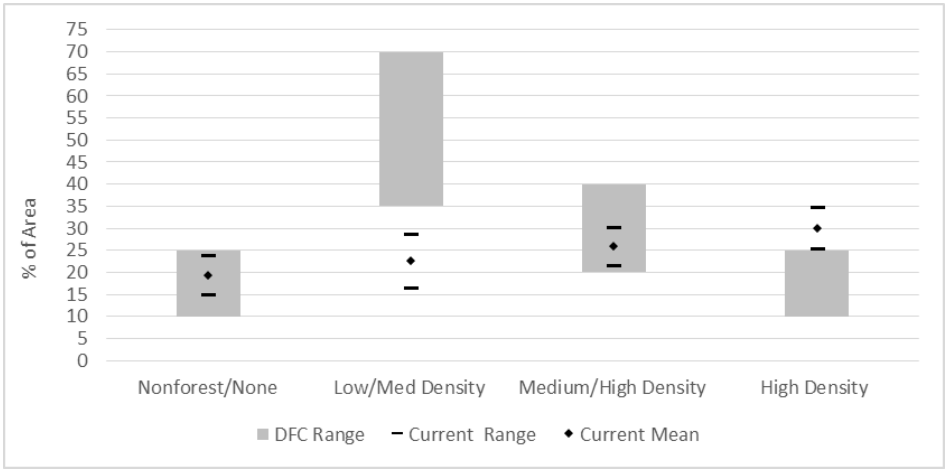


Figure 33. Current and desired percent of area by forest density class, cool moist broad PVT

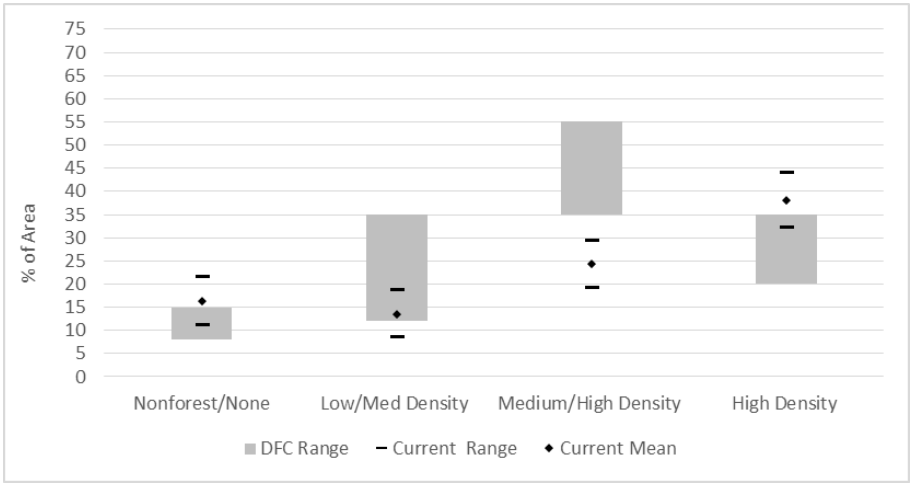
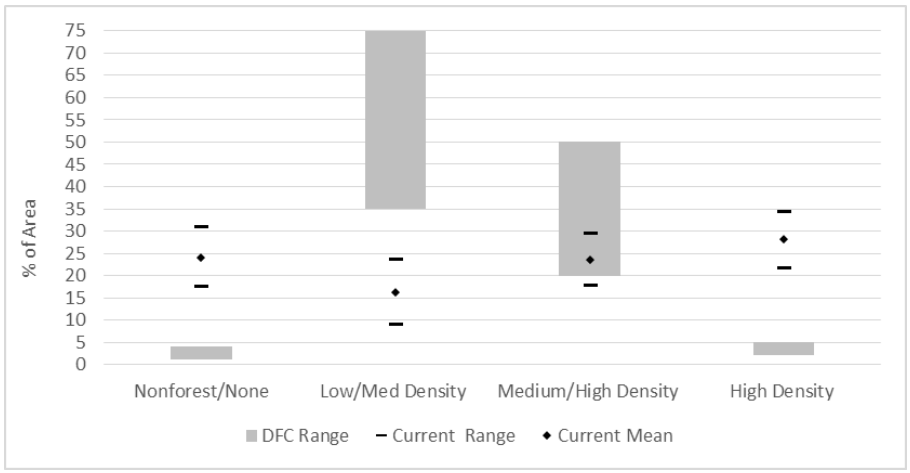


Figure 34. Current and desired percent of area by forest density class, cold broad PVT



The following figures display the current proportions of vertical structure classes forestwide and by broad PVT, compared to the NRV. There are no desired conditions developed specifically for this attribute.

Figure 35. Current proportion of vertical structure classes forestwide compared to the NRV

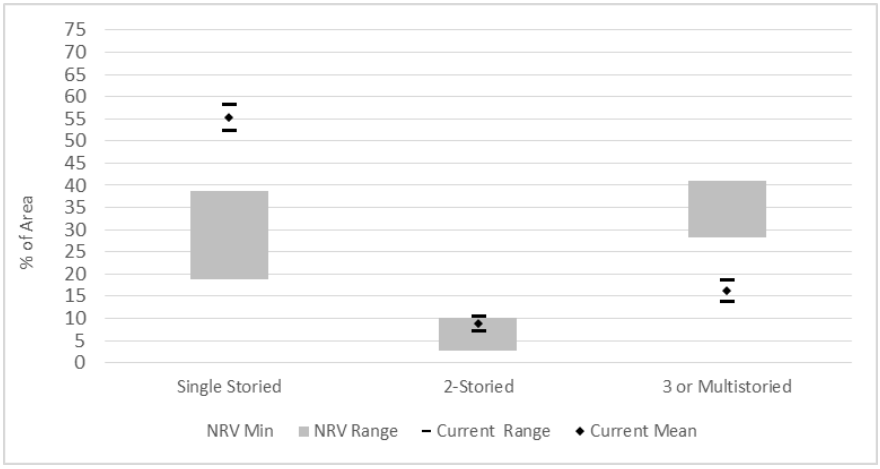


Figure 36. Current proportion of vertical structure classes in the warm dry broad PVT compared to the NRV

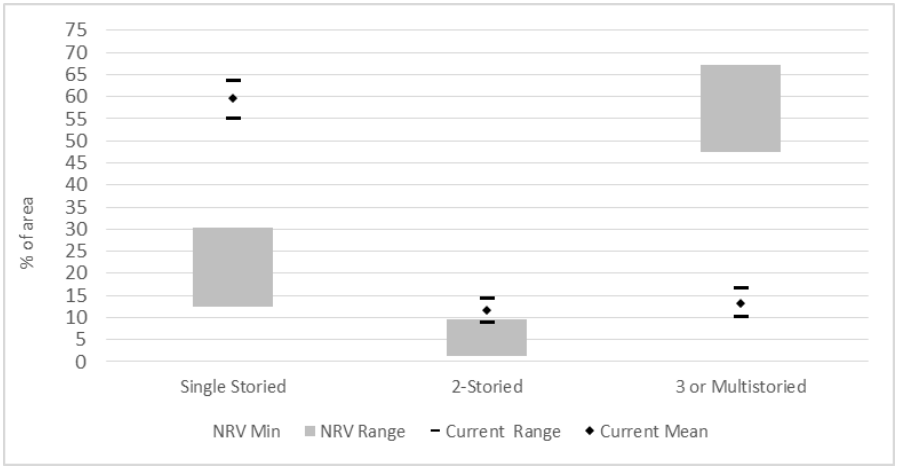


Figure 37. Current proportion of vertical structure classes in the cool moist broad PVT compared to the NRV

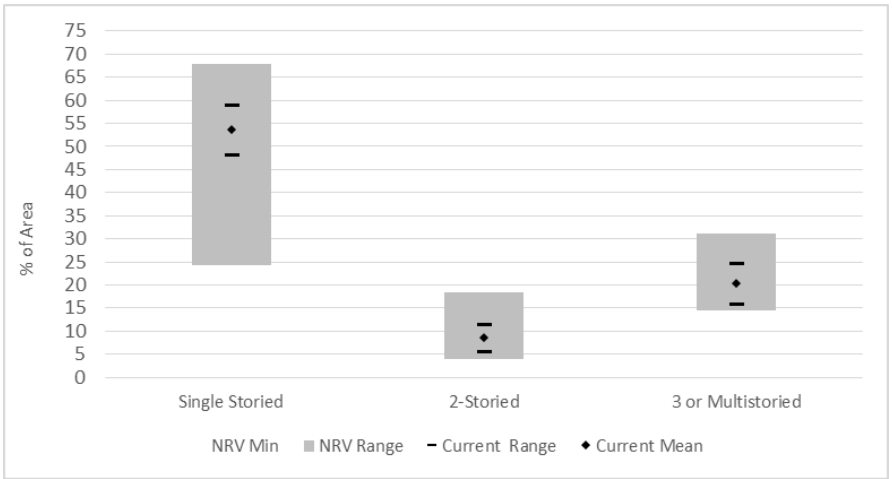
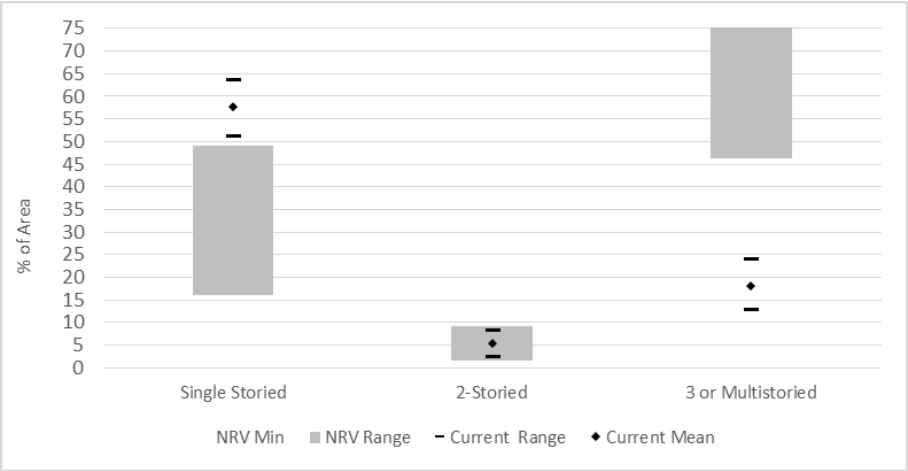


Figure 38. Current proportion of vertical structure classes in the cold broad PVT compared to the NRV



Early successional forest patches

The abundance, average, and range of sizes of early successional forest patches (transitional and seedling/sapling size classes) is the key ecosystem characteristics to represent landscape pattern because this condition is quantifiable, represents likely patterns of older forests, and is meaningful for many species. Openings in the forest are created after a stand-replacing disturbance, and are the most distinct and easily detectable structural conditions in a forested landscape because they are dominated by grass, forbs, shrubs, and short trees. They are meaningful to many wildlife species and also represent the initiation point in forest development, the foundation upon which rests the pattern of the future forest. Table 6 compares results of the NRV analysis (which is the desired condition) with the current condition. The two indicators used are:

- *Average patch size*, which is a simple arithmetic mean; and
- *Area weighted mean patch size*, in which the mean is weighted based on the size of the patch. This metric reflects the largest average patches that would occur.

An opening was included in the calculation for as long as it remained in the seedling/sapling size class. This provides the full ecological picture of the extent and duration of forest openings. A patch analysis was also run to inform the development of timber standards related to maximum opening sizes that can be created with even-aged timber harvest.

There was rarely if ever a decade historically when there weren't openings created by fire somewhere on the HCL NF. The majority of fires were relatively small (as indicated by the arithmetic average). However, when the big fires did occur, they were very large (as indicated by the area weighted mean). These large fires would typically be associated with warm climatic periods and drought conditions.

Table 6. Existing and natural range of variation of early successional forest patch size[2] acres

Attribute	Forestwide	Warm Dry	Cool Moist	Cold
NRV[3] Mean Patch Size of patches	81 (35-139)	29 (21-57)	95 (37-164)	33 (17-68)
NRV[3] Area Weighted Mean Patch Size[1]	10,213 (223-72,288)	174 (47-4,210)	7,833 (195-45,694)	142 (24-868)
Existing Condition Avg. Patch Size	113	49	76	39

Attribute	Forestwide	Warm Dry	Cool Moist	Cold
Existing Condition Area Weighted Mean of patches	25,507	1,615	7,296	2,033

1 Weighted mean patch size provides an indication of the maximum or largest patch size
2 Patches had a minimum size threshold of 10 acres. Source for all data: SIMPPLLE modeling.

Relationships between VMap and FIA Existing Conditions

Both FIA plots and VMap are used to depict existing vegetation. While the grid plots provide the most statistically reliable estimates, the VMap provides the spatial depiction that is needed for modeling into the past and future. To create the modeling dataset, VMap was updated to be as similar to FIA as possible. Inherent differences remain due to differences in methods such as data collection methods and timing. However, the depictions from plots and the map should be similar, to ensure that the comparison between the existing condition and the NRV are valid as a cornerstone of desired conditions. The following information discloses the level of similarity between the two data sources of the existing condition and their relationship to the desired condition. Further information is available in the planning record.

- Forestwide, VMap and the FIA plots correlate well for cover type. While the map shows slightly less ponderosa pine and more mixed mesic conifer, the trends compared to the desired condition are consistent. In the warm dry broad PVT and cool moist broad PVT the map and plots closely agree. In the cold broad PVT, VMap closely agrees with FIA for most cover types. However, the map shows lower amounts of lodgepole pine and higher amounts of spruce/fir than the plots. The accuracy of the cold PVT is the most unreliable of all the potential vegetation types because it is present on the smallest area and therefore represented by the fewest plots.
- Forestwide, the mapped values are nearly within the plot confidence interval for all size classes except medium. Both sources indicate a need to decrease this class relative to the desired condition. In the warm dry broad PVT the biggest discrepancy between plots and the map is seen in the medium class, with VMap indicating that more is present. All other classes are similar for both data sources. VMap closely agrees with FIA plots in all cases for the cool moist broad PVT. In the cold broad PVT, VMap shows slightly higher amounts of small and medium size classes, and slightly less grass/shrub, than the FIA plots. However, the data sources agree that a decrease in small and medium with an increase in the large size class is warranted relative to the desired conditions.
- Forestwide, VMap is nearly within the FIA estimate confidence interval for all canopy cover (density) classes except 60%+. Both the map and plots indicate a desired decrease in the 60%+, although the magnitude of the desired change varies. In the warm dry broad PVT, VMap is generally within the confidence interval for plot estimates except the 60%+ is slightly high (to a lesser degree than Forestwide). The sources agree that a decrease in this class is warranted to achieve the desired condition range. Similar to the Forestwide scale, in the cool moist broad PVT, VMap indicates that more 60%+ is present than the FIA plots. Both sources indicate a reduction is warranted to achieve the desired condition. In the cold broad PVT, VMap shows much less of the nonforested/<10% tree canopy than FIA plots, as well as more of the 60%+ class. The sources agree on a desired trend of increasing the 10-39% class and decreasing the 60%+ class, while the 40-59% class is at the low end of the desired range.

Modeling and evaluation of vegetation change

The vegetation management strategy for the HLC NF is to manage the landscape to maintain or trend towards vegetation desired condition. Modeling was done to define the natural range of variation; inform the development of desired conditions and identification of lands suitable for timber production; provide estimates for vegetation treatments, acres, and timber outputs over time; and evaluate the degree to which each alternative moves towards desired conditions. Three vegetation models were used:

- Forest Vegetation Simulator
- Spectrum
- SIMulating Patterns and Processes at Landscape scaLEs (SIMPPLLE)

The models are used interactively to analyze vegetation as follows:

1. Yield tables for all potential vegetation management options and disturbance events are developed by running Forest Vegetation Simulator. Yield tables show timber volume and changes to vegetation through time associated with different management alternatives.
2. Expected future wildland fire and insect disturbances are modeled in SIMPPLLE.
3. The acres of expected disturbances and severities from SIMPPLLE are input into Spectrum, which assigns the changes to vegetation in those areas based on yield tables.
4. The Spectrum model is run to develop a schedule of future vegetation treatments and timber outputs that are designed to move the landscape toward desired conditions and other objective functions. The model uses the yield tables to assign post-treatment or disturbance conditions.
5. The projected treatment types, acres, and resulting vegetation changes from Spectrum are input back into SIMPPLLE.
6. SIMPPLLE is run into the future to provide an analysis of expected vegetation conditions, based on a finer-scale integration of ecological processes and disturbances, and management activities.

Modeling simulations of vegetation five decades into the future were conducted to analyze alternatives. Fifty years is a reasonable time period over which to model and capture vegetation trends, considering that some changes occur quickly while others are gradual. Fifty years is a relatively short time period to portray shifts that occur for long-lived conifers. However, there is an increasing level of uncertainty with ecological and social change the farther into the future you go, especially related to climate change.

In the Spectrum model, vegetation management activities were planned over time in each alternative by considering land allocations, desired conditions, resource constraints, and budget limitations. Spectrum was run with an objective that was in keeping with the theme of the alternative. Outputs from the Spectrum model are displayed in the Timber section of this appendix.

Projected treatments from Spectrum were integrated into the SIMPPLLE model for a spatial analysis of vegetation change over time, interacting with succession, fire, insects, and disease. Thirty simulations were run to capture the variability associated with disturbances. The model was run with a “warmer” climate condition for all modeling periods. The attributes modeled quantitatively include species composition, forest size classes, and forest density.

Out of necessity, all models simplify complex and dynamic relationships between ecosystem processes and vegetation over time and space. The models use assumptions based on corroboration of data and review of scientific literature, as well as professional judgement. Although the best available information is used, uncertainty in the results remains because of the inability to accurately predict the timing, magnitude, and location of future disturbances. In addition, modeling potential treatments, accurately representing limitations, and integrating multiple ecological processes is very complex.

The results from these models provide information useful for understanding vegetation change over time and the relative differences between alternatives. Models are one tool to help inform the analysis; they provide information of comparative value, and are not intended to be predictive. Model outputs augment other sources of information, including research and professional knowledge.

SIMPPLLE model design

SIMulating Patterns and Processes at Landscape scaLEs (SIMPPLLE)(Chew, Moeller, & Stalling, 2012) is a model that simulates changes in vegetation on landscapes in response to both natural disturbances and

management activities, as they interact with climate. This model was used for two purposes: 1) to calculate the NRV; and 2) to project disturbances and vegetation conditions into the future.

The VMap was the base map used to develop the input map for SIMPPLLE, and it was calibrated with FIA plot data for vegetation species and size classes. Broad PVTs, GAs, ownership, and other features such as wildland urban interface areas were also integrated.

SIMPPLLE takes a landscape condition at the beginning of a simulation and uses logic to grow the landscape through time, while simulating processes (growth, fire, insects, management, etc.) that might occur and the effects of those processes. One timestep is ten years, and simulations are made for multiple timesteps. The logic assumptions in the model come from a variety of sources, including expert opinion, empirical data, data from other models, and from initial model logic files that reflect a long history of trial-and-error and research that has been maintained and passed from forest to forest.

One of the main utilities of SIMPPLLE is its stochastic nature. The model is run for multiple iterations to allow the manager to see a variety of possible projections, look for patterns, and adjust management responses. Managers cannot know with precision the specific types, locations, and extents of disturbances that will occur on the landscape. Therefore, SIMPPLLE will randomly assign fire, insect, and disease processes on the landscape in a manner consistent with the nature and probability of these disturbances.

The other utility of SIMPPLLE its spatially interactive nature. A process occurring on one site is dependent, to an extent, on the processes that occur on adjacent sites. For example, SIMPPLLE simulates fire by assigning fire starts with a probability consistent with historic records for the area and climate. Each start is given the opportunity to grow. The direction, size, and the type of fire that spreads, is dependent on the surrounding vegetation, climate, elevational position, and wind direction. The fire process will stop according to the probability of a weather ending event, successful fire suppression, or natural barriers such as the treeline or water. SIMPPLLE will determine the effect of the fire by considering whether there are trees present capable of re-seeding/re-sprouting, whether the stand's fuel conditions have been reduced, and/or if there has been a change in size and/or species on the site.

A number of updates of the logic files and assumptions in SIMPPLLE were conducted to reflect the ecosystems and processes on the HLC NF. These include modification of successional pathways, regeneration logic, insect/disease probabilities, and fire logic. There remains uncertainty due to the ecological complexities and lack of ability to predict the future. 30 model simulations were run to capture the variability and uncertainties.

Please refer to the planning record document, *Helena-Lewis & Clark NF SIMPPLLE Modeling for Forest Plan Revision* for more detailed metadata. In addition, results for the NRV modeling are displayed in a report in the planning record, *Helena and Lewis & Clark National Forest Natural Range of Variation Analysis for Forest Plan Revision, Summary Report March 2017*". The sections below display results from the future modeling of alternatives for the DEIS. For all results, the mean of all 30 runs is shown.

SIMPPLLE model results for terrestrial vegetation

Future Insects and Disease

SIMPPLLE is used to estimate the probable extent and severity of insects and disease in the future, taking into account expected climate, vegetation treatments, and fire suppression. The average acres projected do not imply an "even flow" of acres affected over time. The acres infested would vary by decade. These estimates have a high level of uncertainty.

Figure 39. Mean acres per decade affected by insects, by alternative, across five decades

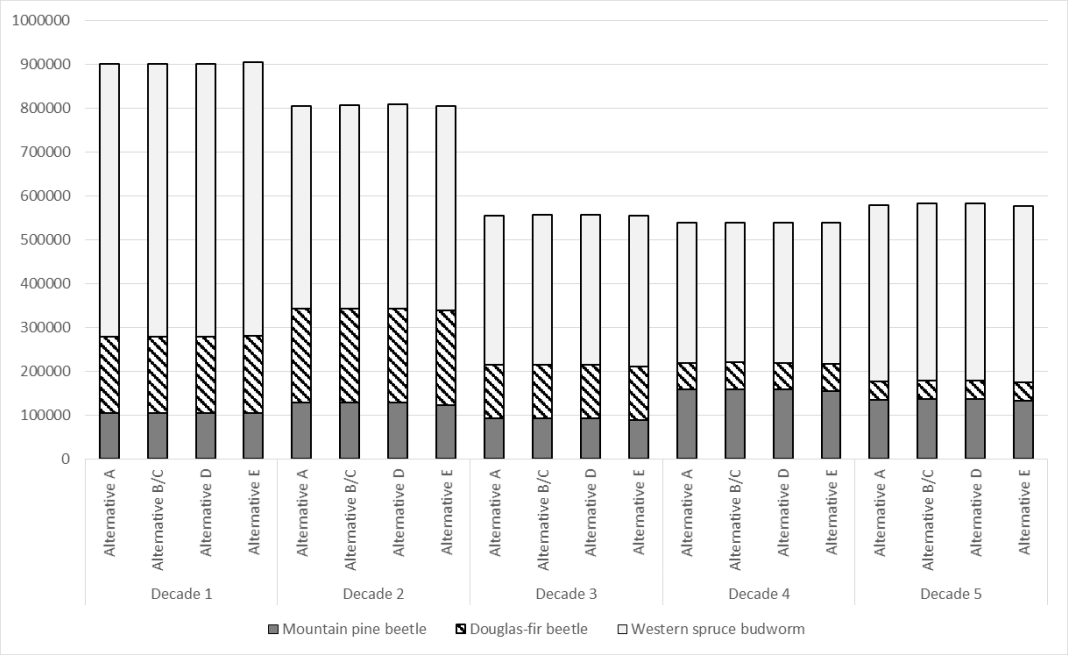


Figure 40. Average acres per decade affected by mountain pine beetle, by alternative

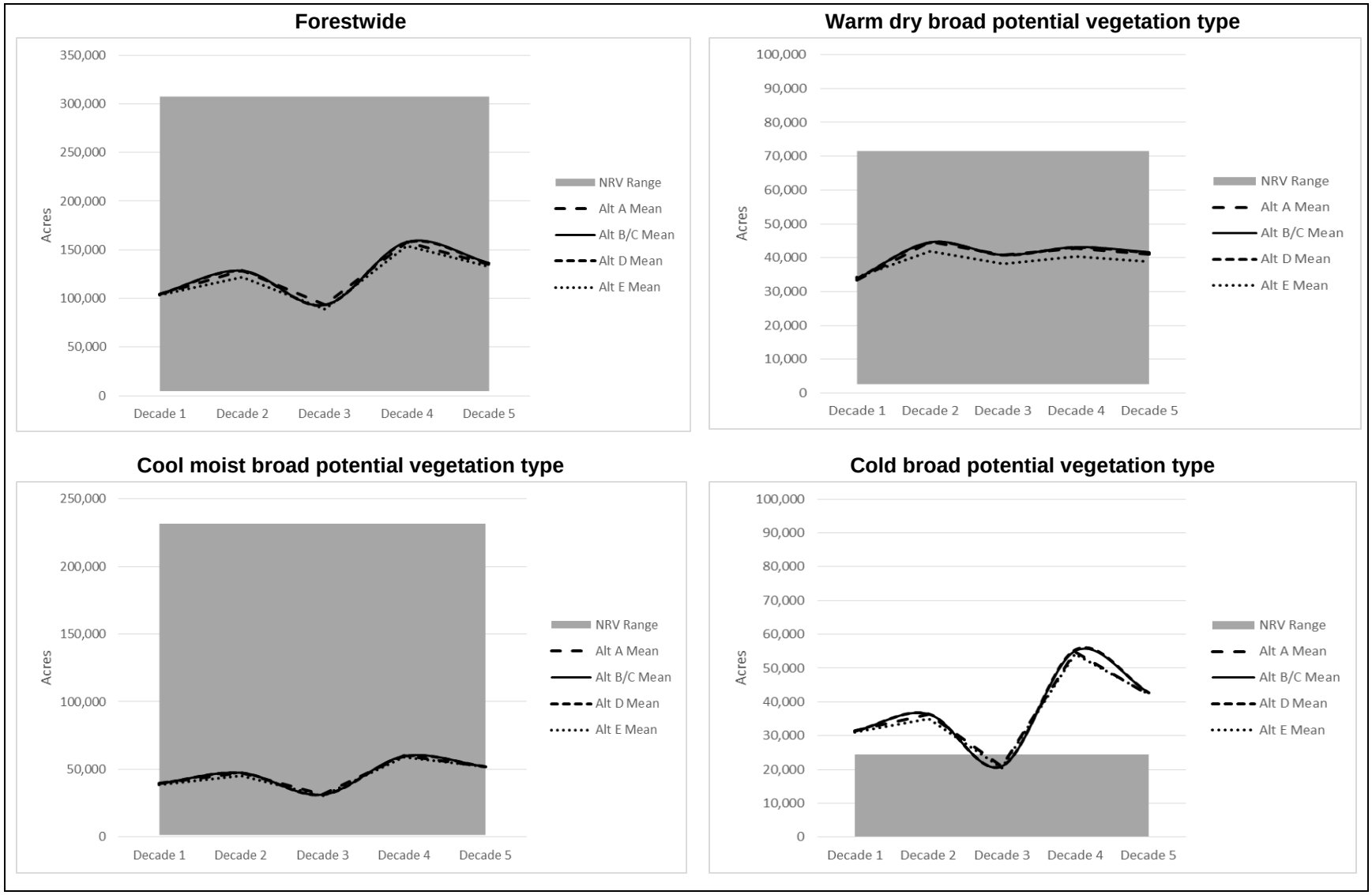


Figure 41. Average acres per decade affected by Douglas-fir beetle, by alternative

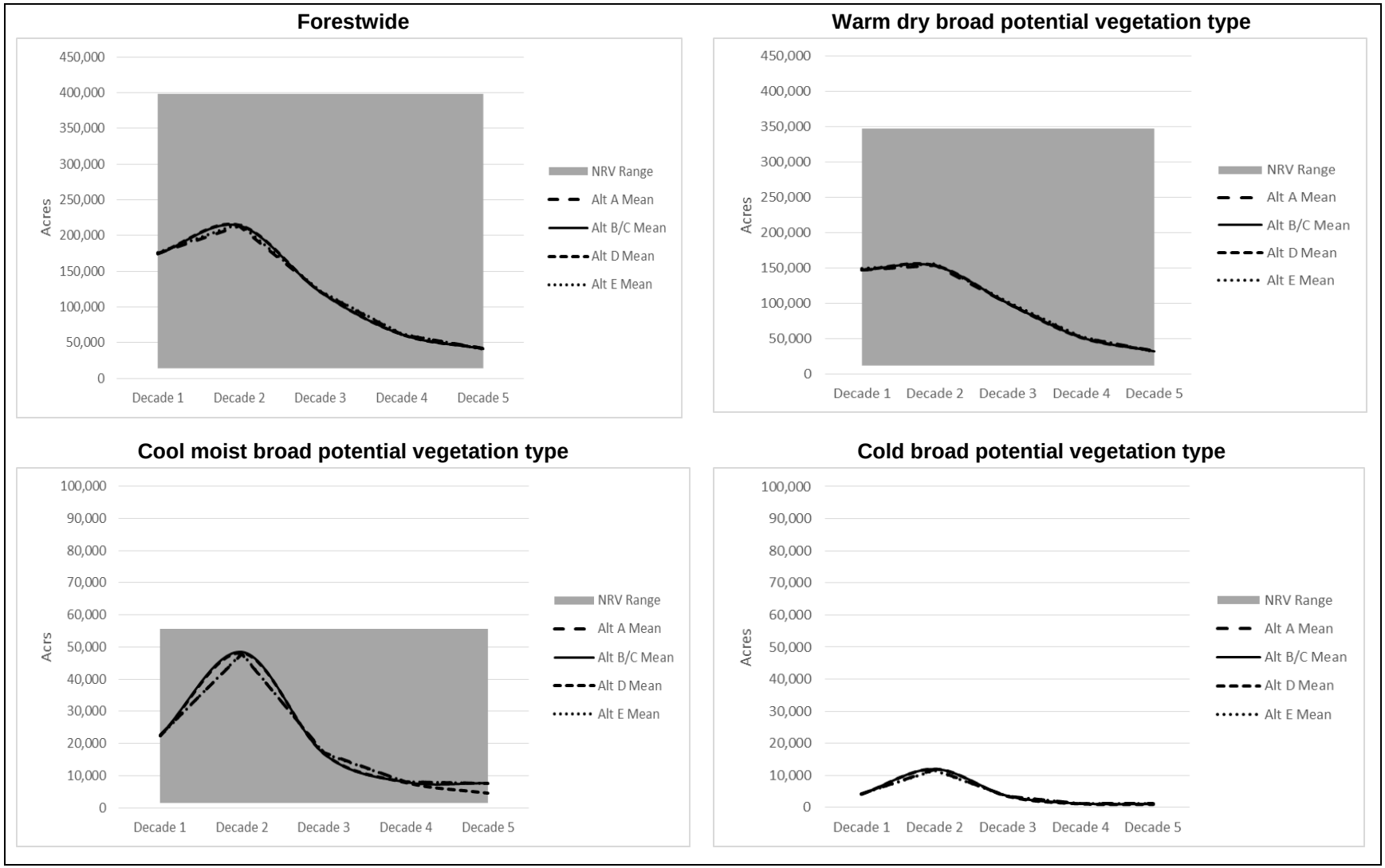


Figure 42. Average acres per decade affected by western spruce budworm, by alternative

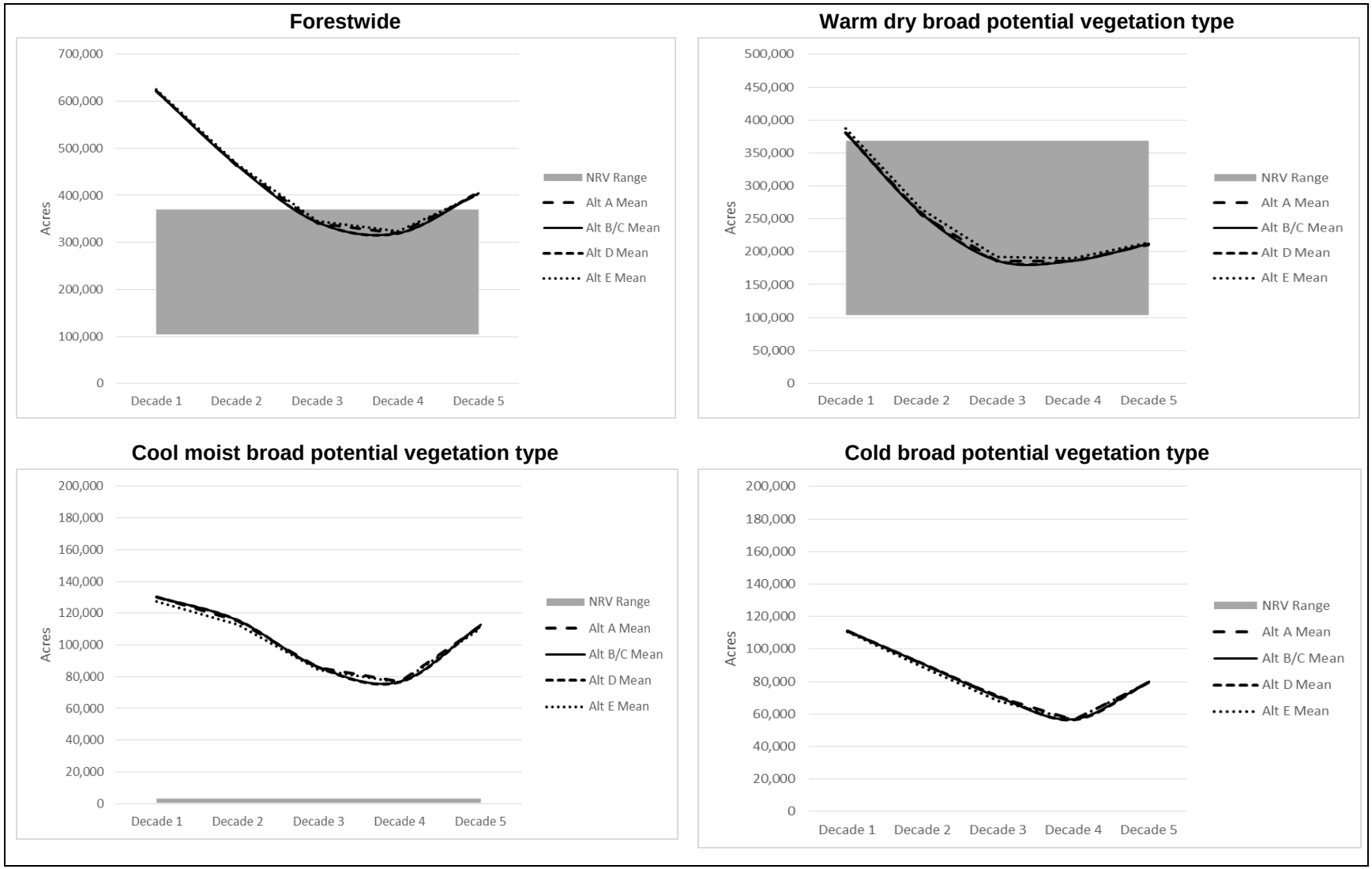
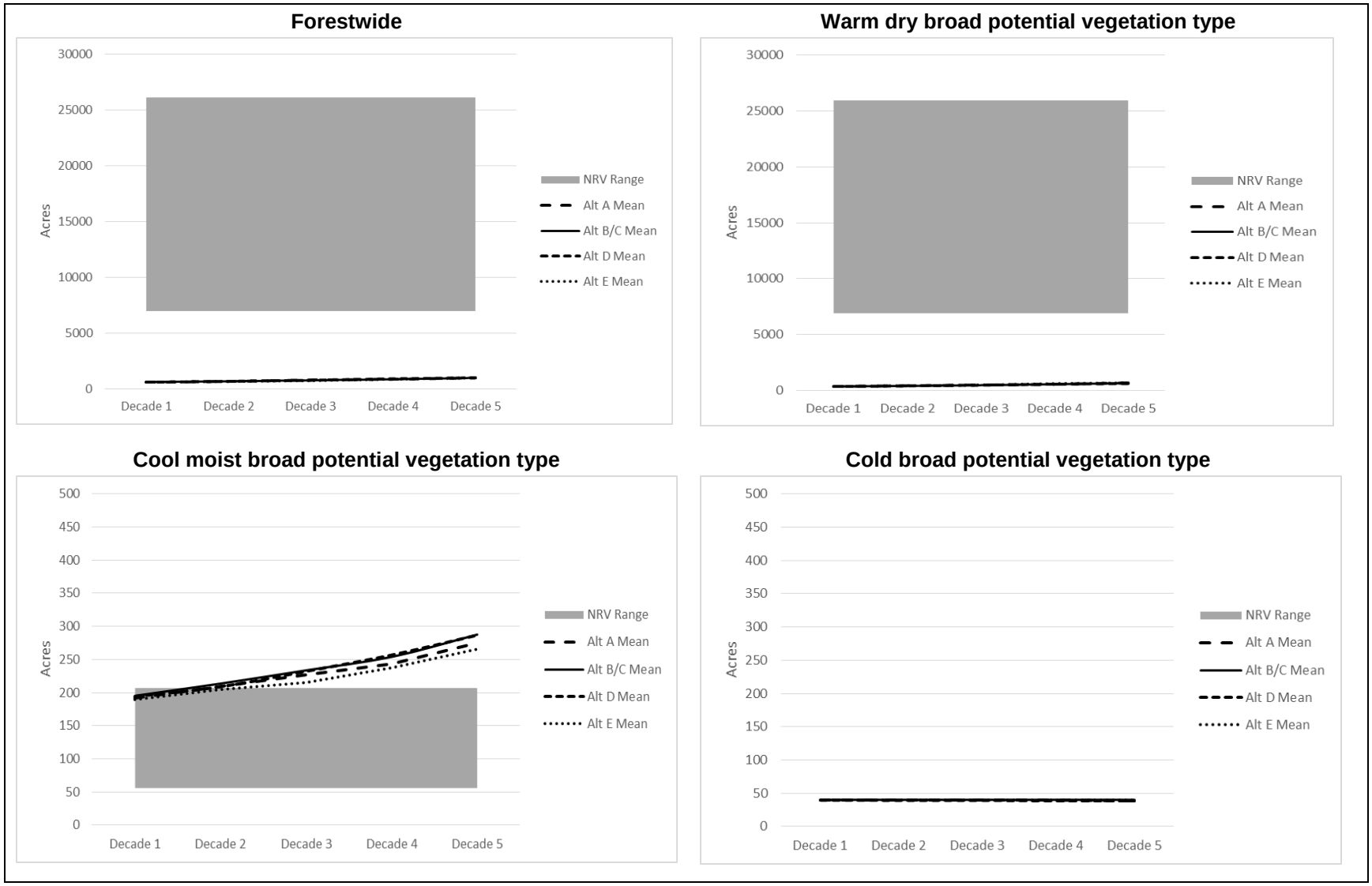


Figure 43. Average acres per decade affected by root disease, by alternative



Future terrestrial vegetation conditions

The following sections show the future conditions for the key ecosystem characteristics identified for composition, structure, and function of terrestrial vegetation. The mean estimate of each condition depicted across 30 SIMPPLLE model runs, along with the existing condition and desired condition ranges. The existing conditions are based on FIA or FIA intensified grid plots. In some cases, this existing condition is not consistent with the starting condition of SIMPPLLE (based on VMap), due to the disparity in data sources. The expected trend is more crucial to the analysis than the overall endpoint.

Cover type

The modeled abundance of forested and nonforested cover types for the 50 year model period are shown in the figures below. Results are included for each R1 broad PVT (unless the cover type does not occur on a given PVT). Nonforested cover types (and size classes) are assigned to areas with less than 20 BA/ac or 100 TPA of trees. Most of these areas are grass or shrublands, but some are very open forest savannas or recently disturbed areas where reforestation has not yet occurred. Nonforested cover types are also displayed by GA, because there are desired conditions for this type at the GA scale. In addition, specific types are displayed for several GAs that have specific desired conditions developed that vary from the forestwide ranges: the Crazies, Elkhorns, Divide, Highwoods, Rocky Mountain Range, and Snowies.

Figure 44. Cover types forestwide – desired range and mean at 50 years by alternative

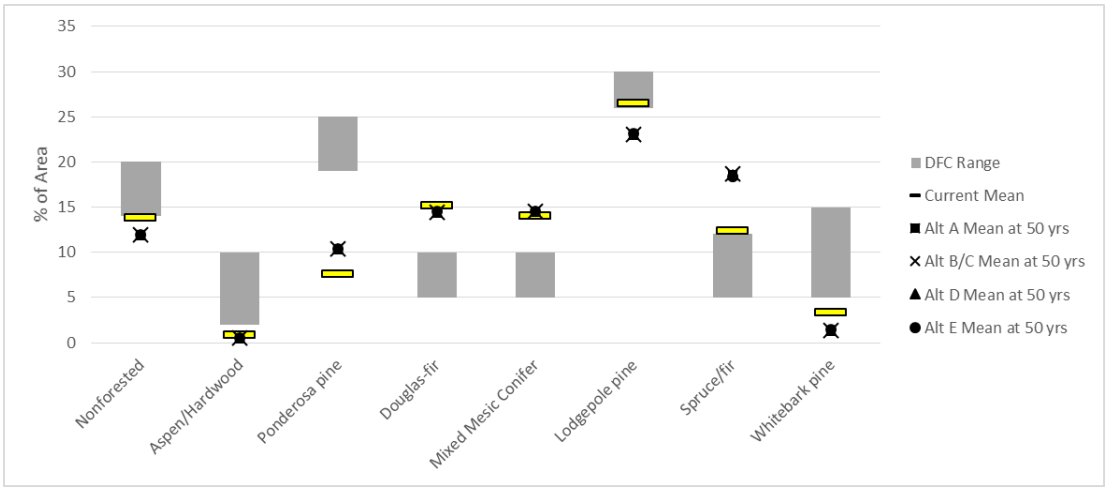


Figure 45. Nonforest cover types by GA, desired range and mean at 50 years by alternative

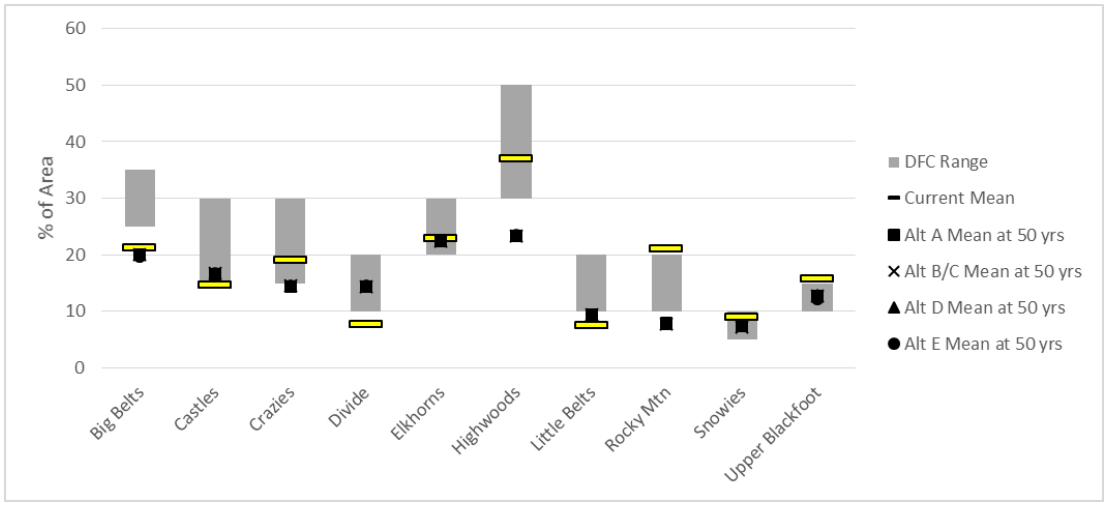


Figure 46. Nonforest cover types over 5 decades

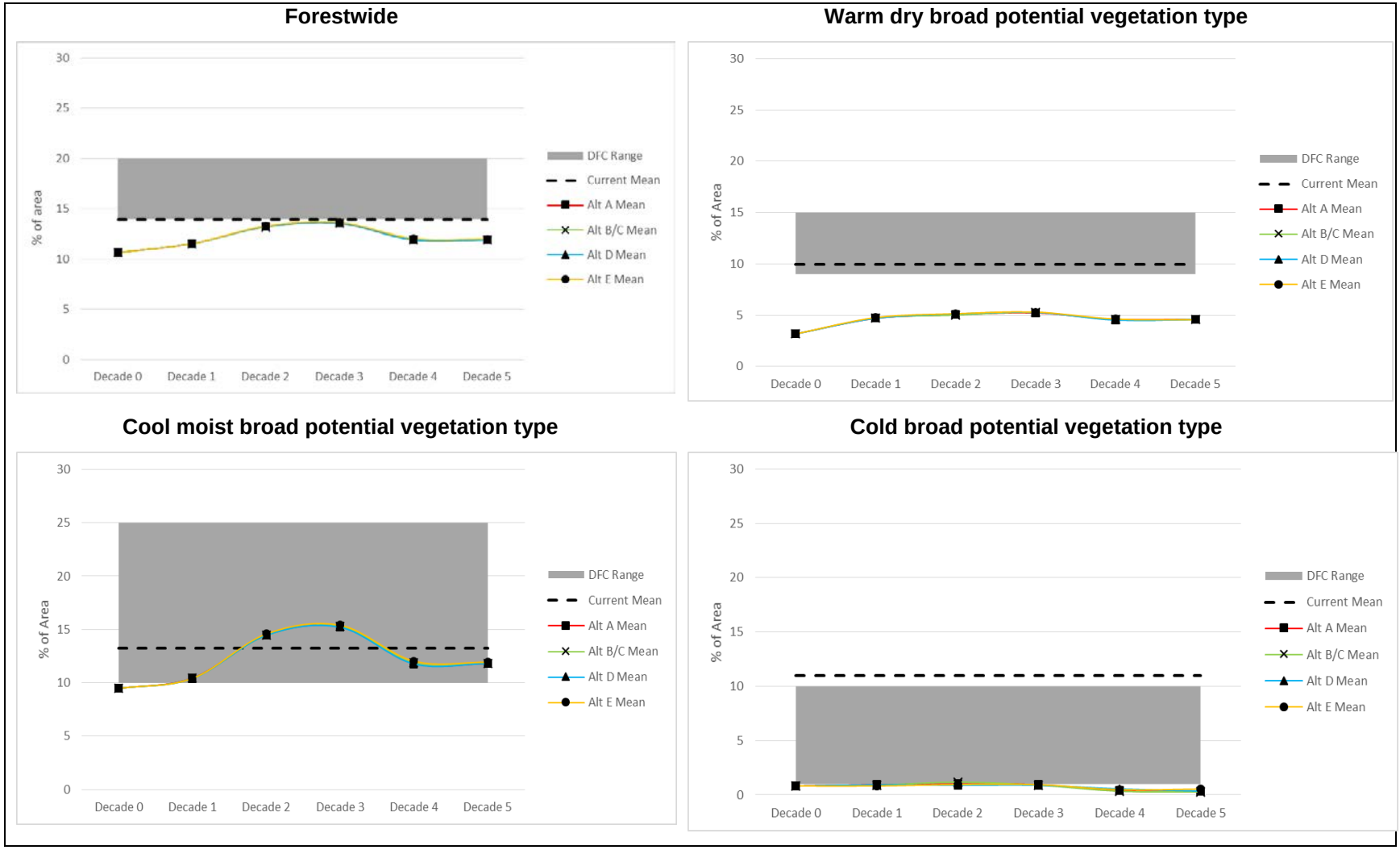


Figure 47. Aspen/Hardwood cover type over 5 decades

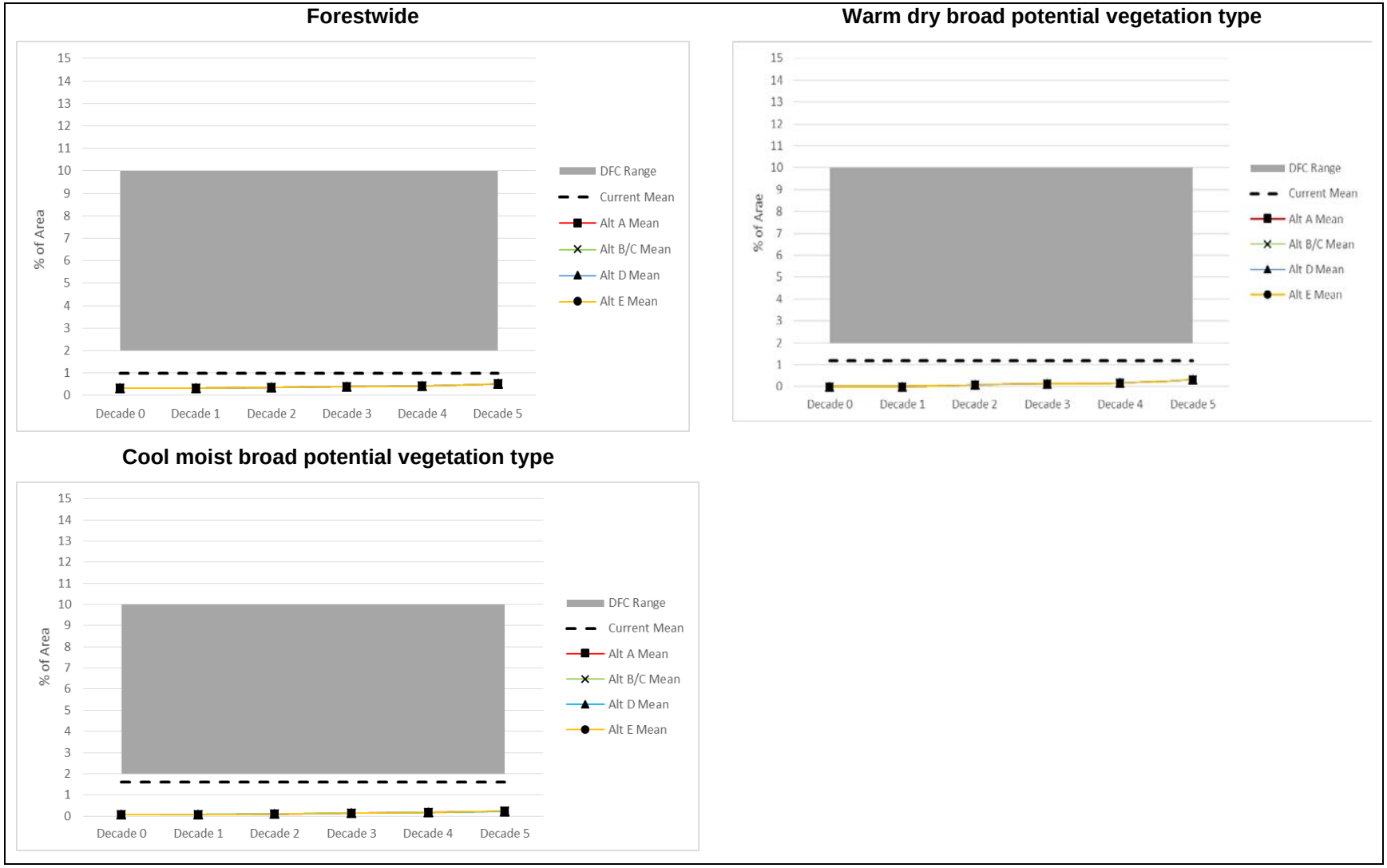


Figure 48. Ponderosa pine cover type over 5 decades

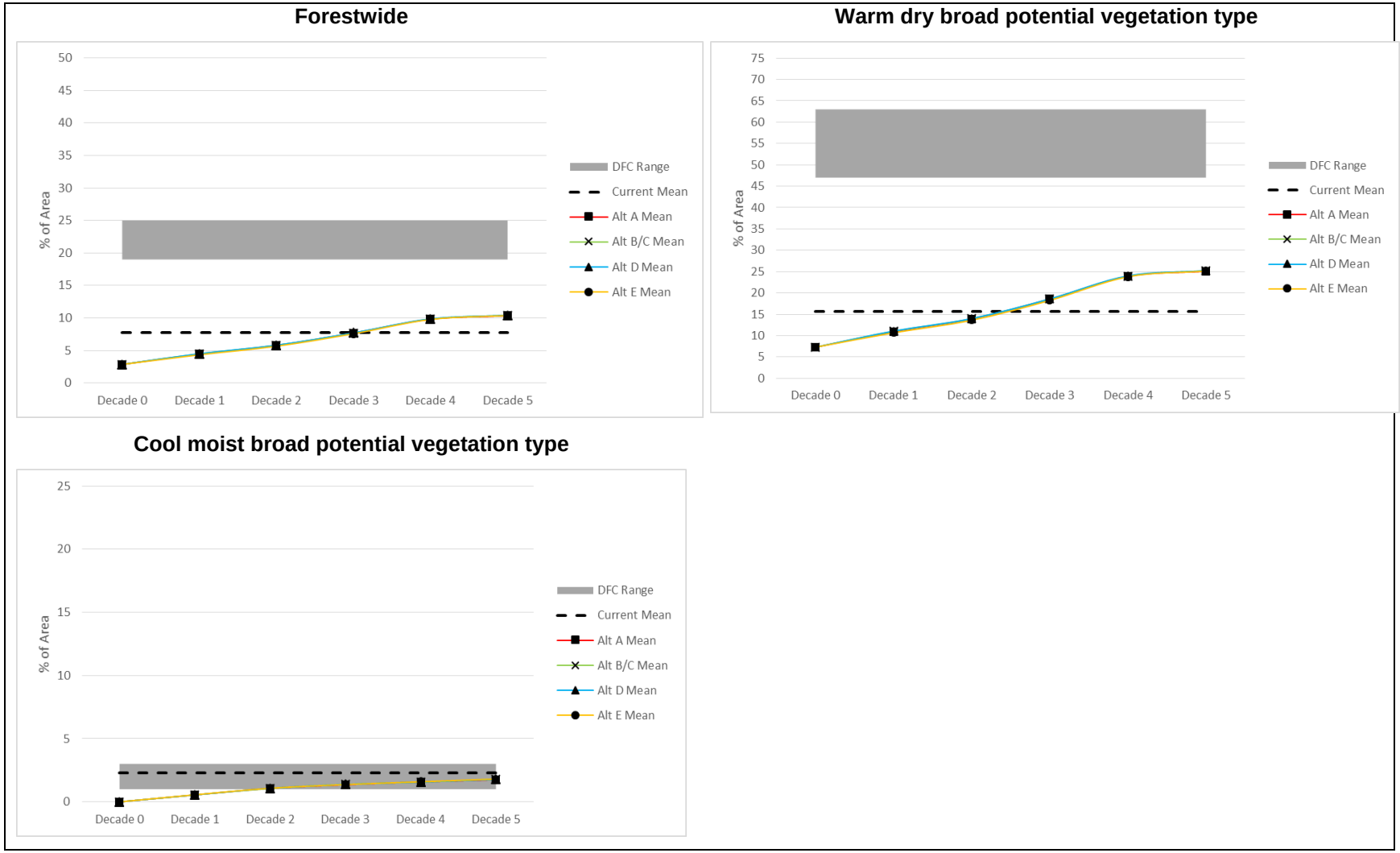


Figure 49. Dry Douglas-fir cover type over 5 decades

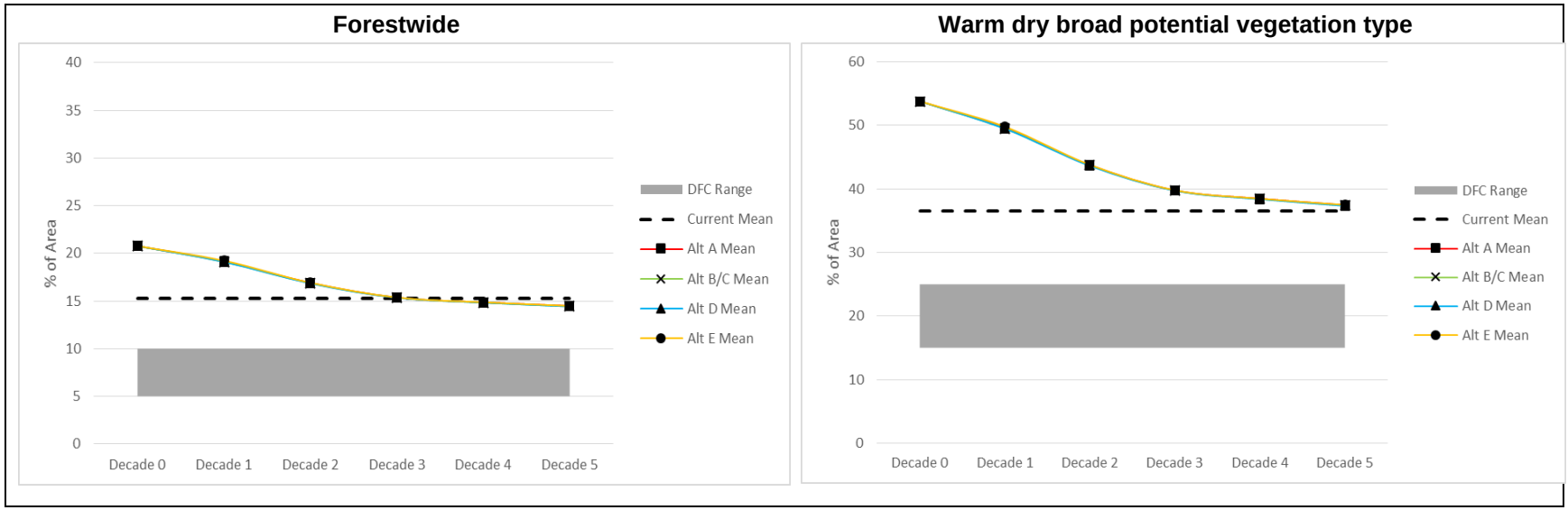


Figure 50. Mixed Mesic Conifer cover type over 5 decades

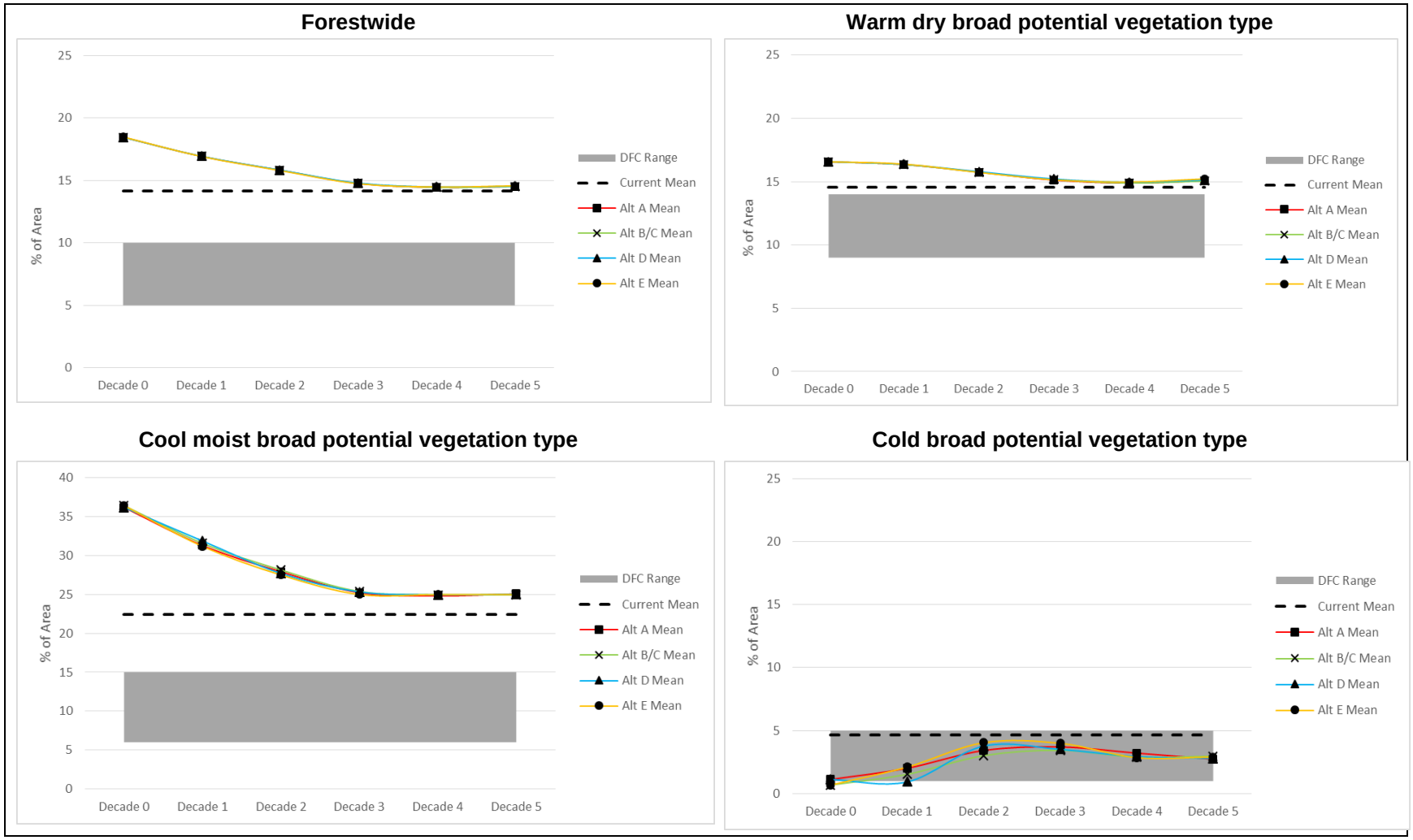


Figure 51. Lodgepole pine cover type over 5 decades

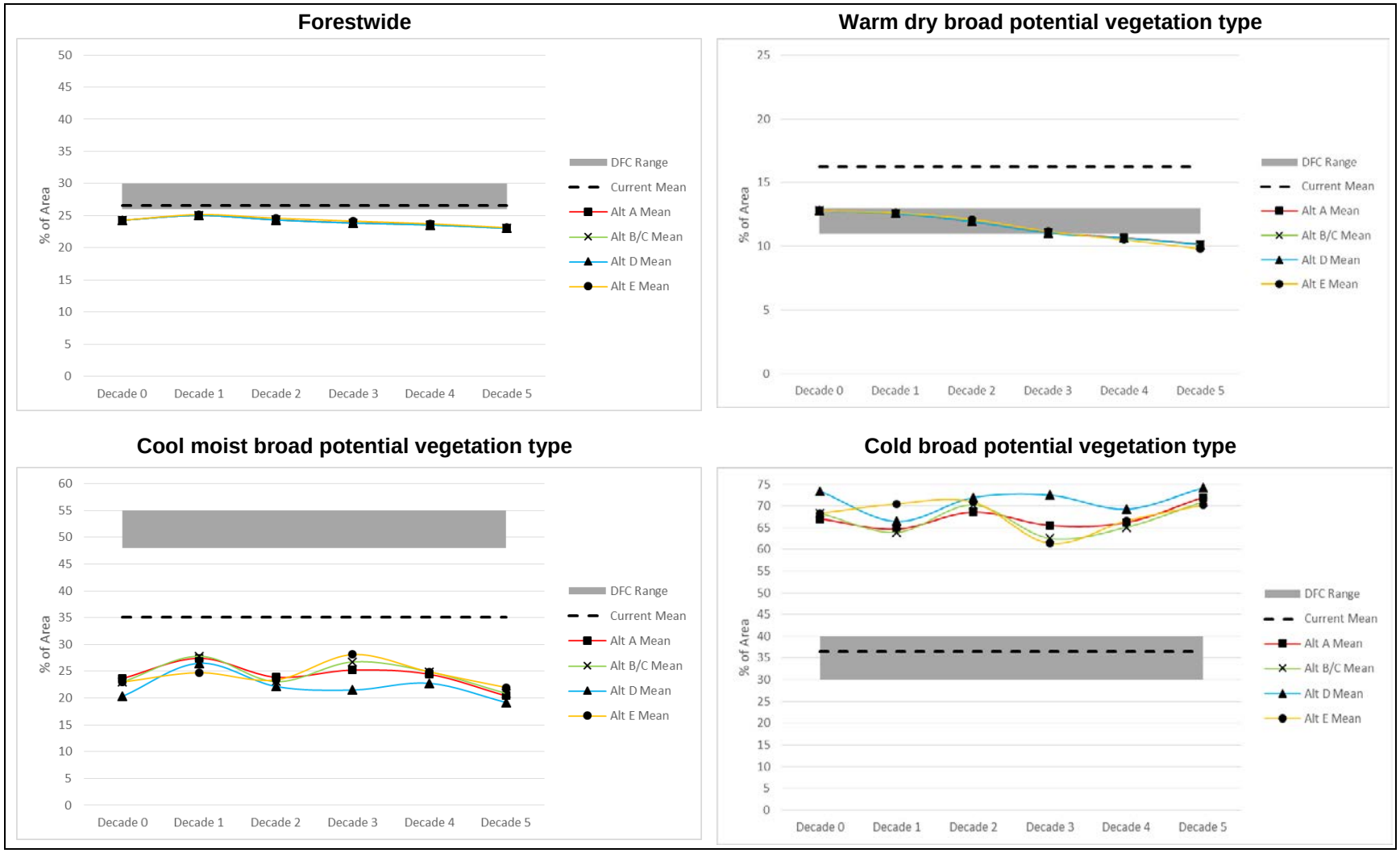


Figure 52. Spruce/fir cover type over 5 decades

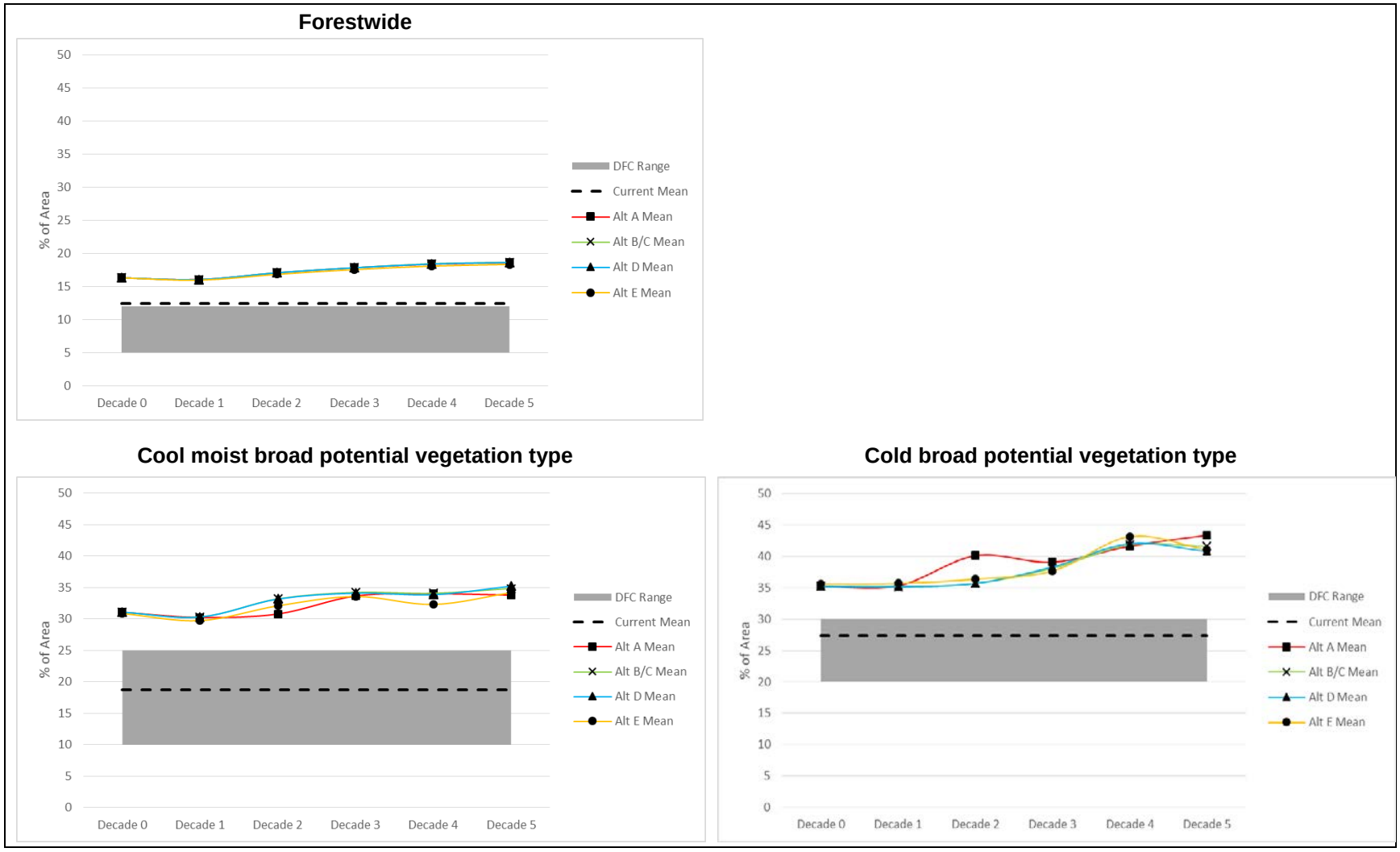


Figure 53. Whitebark pine cover type over 5 decades

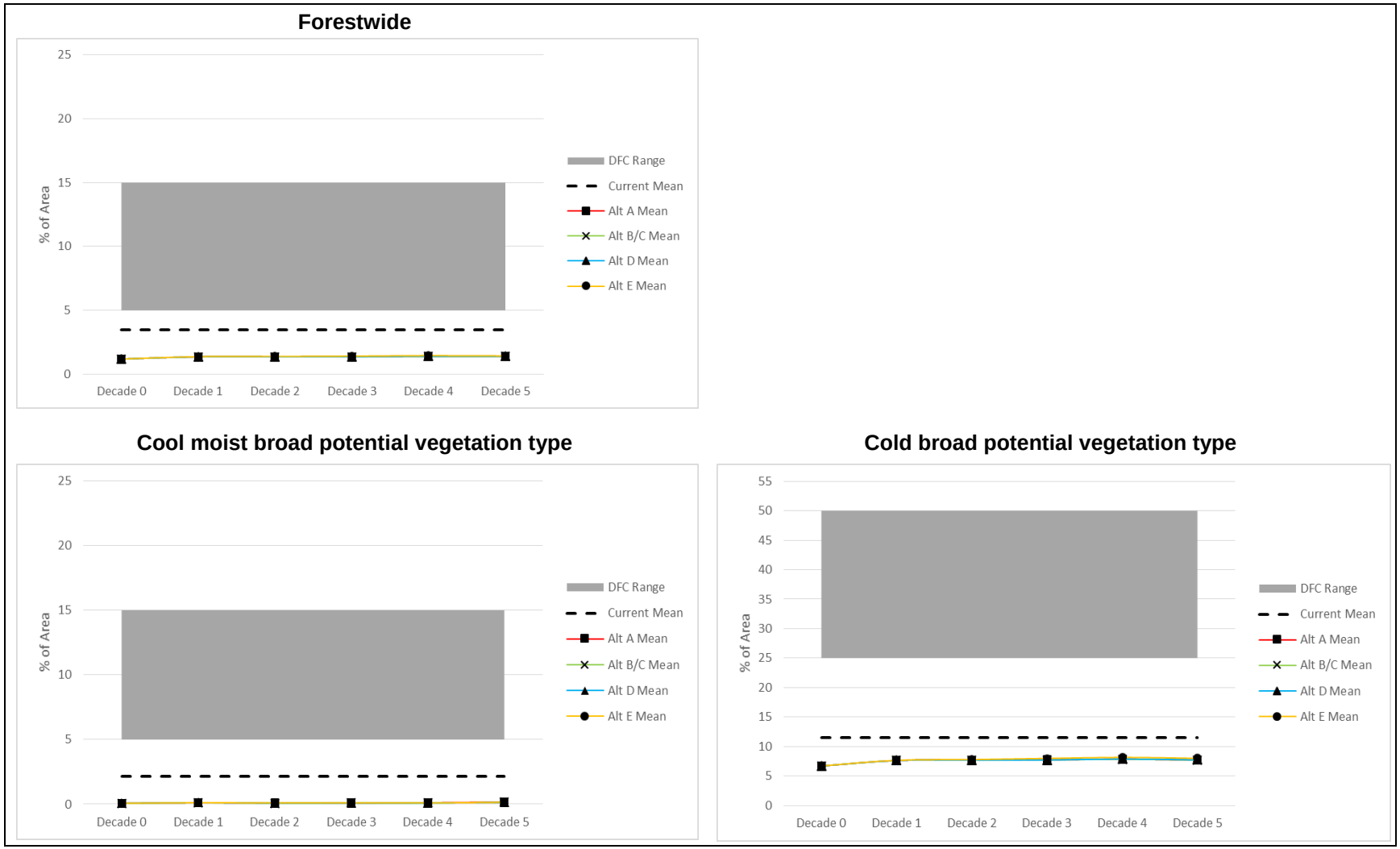


Figure 54. GA-specific cover type results

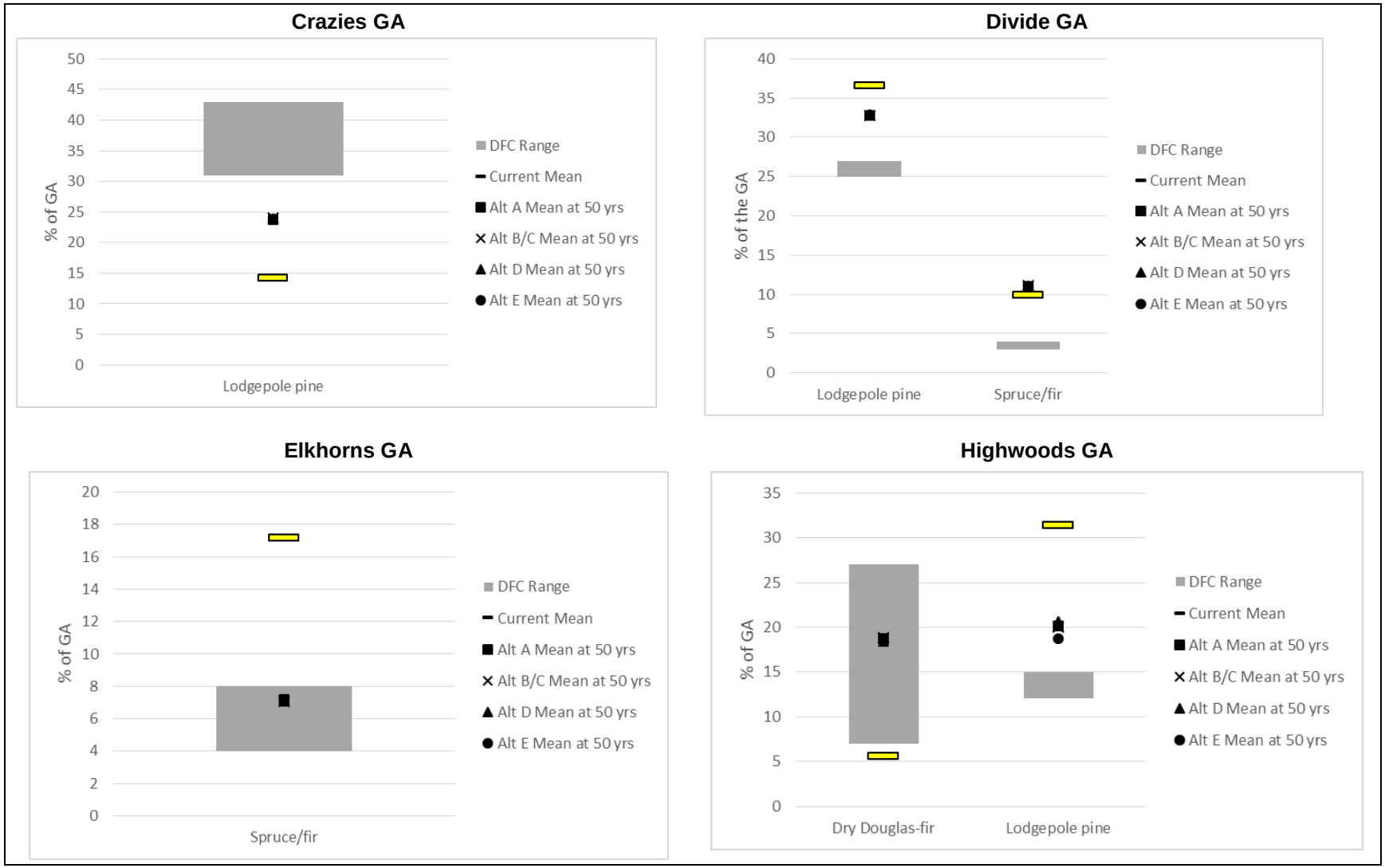
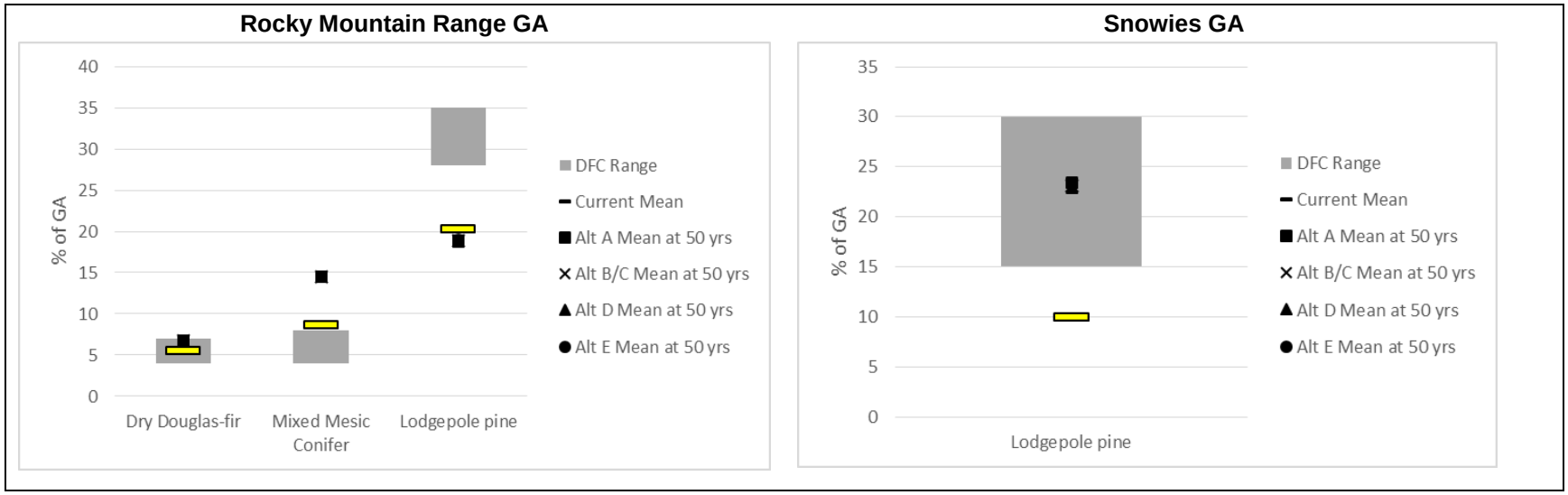


Figure 55. GA-specific cover type results, continued



Tree Species Presence

The figures below shows the mean of tree species over 50 years, compared to the existing condition (FIA) and desired range. Results are shown at the forestwide, R1 broad PVT, and GA scales because desired conditions apply to all of these scales. Western larch is not shown because it is present only in low amounts in the Upper Blackfoot GA (1%). The SIMPPLLE model had a starting point below this amount, and did not predict any change over time under any alternative. Similarly, cottonwood is rare based on FIA plots (< 1% at all scales), and the SIMPPLLE model did not estimate its presence in the future.

Figure 56. Tree species presence forestwide at 50 years, mean by alternative

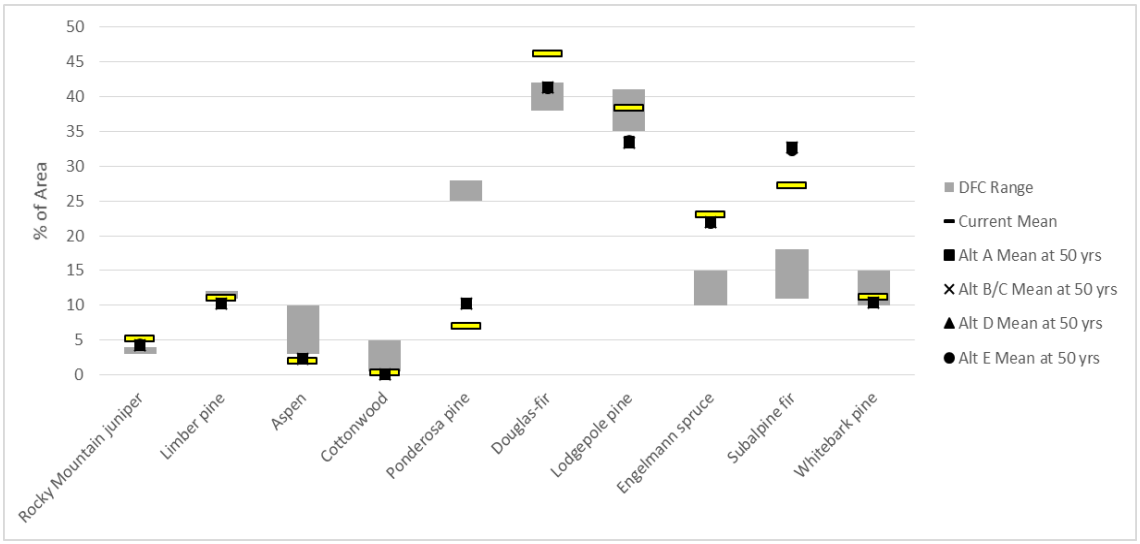


Figure 57. Rocky mountain juniper presence forestwide over 5 decades by alternative

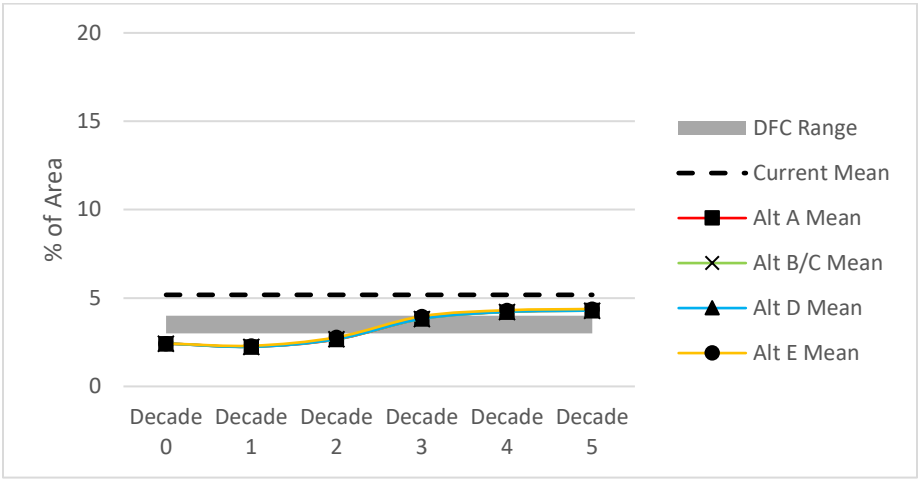


Figure 58. Rocky mountain juniper presence by geographic area, mean at 50 years

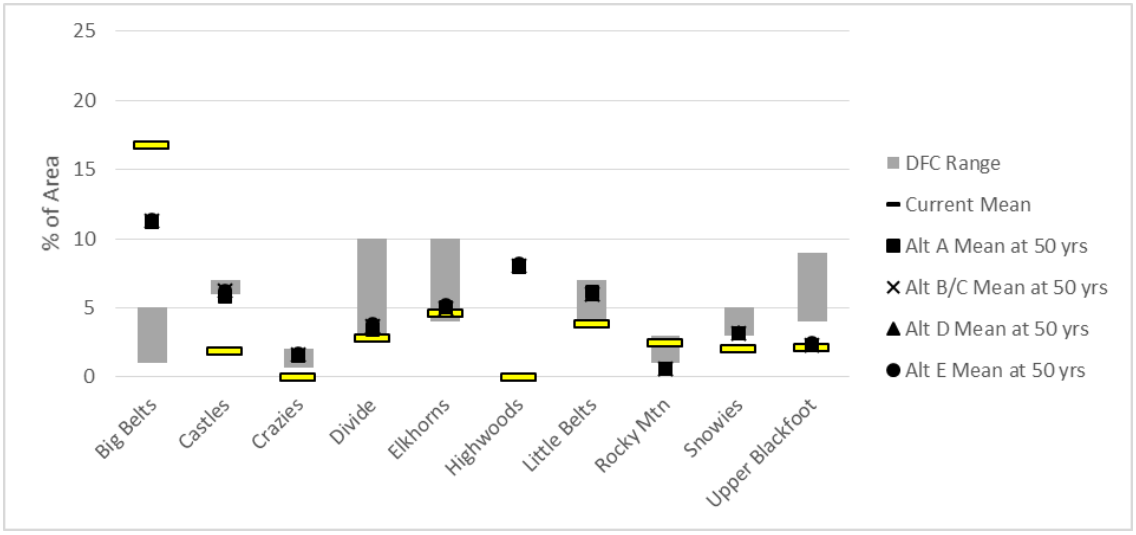


Figure 59. Limber pine presence forestwide over 5 decades by alternative

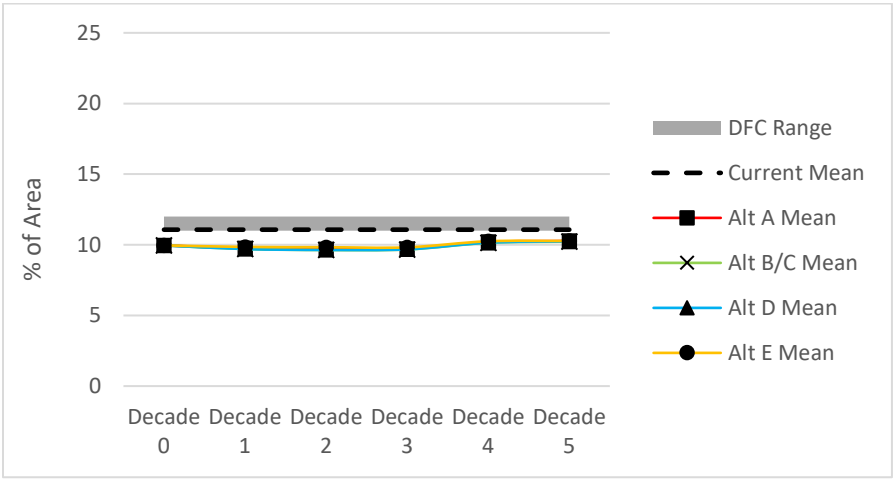


Figure 60. Limber pine presence by geographic area, mean at 50 years

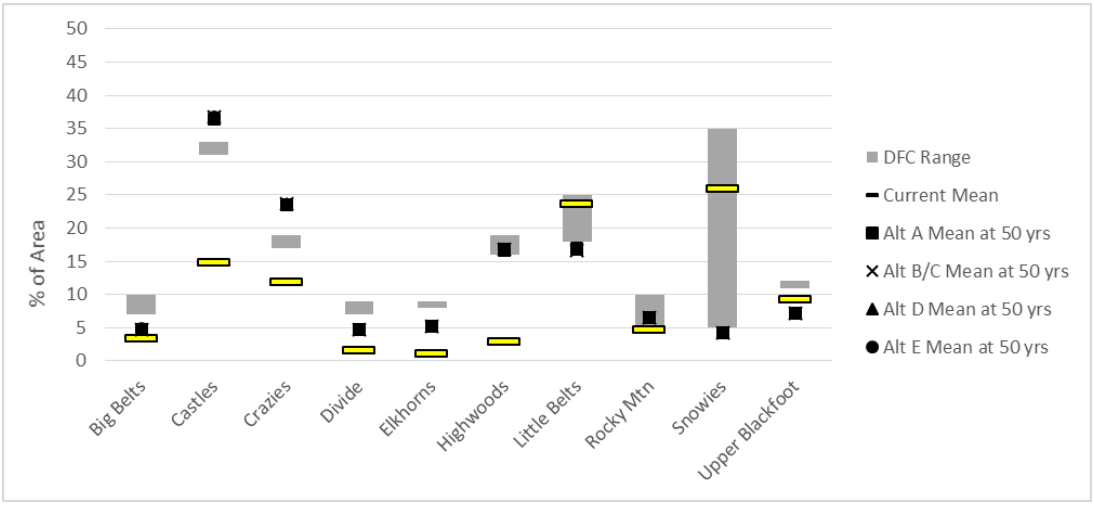


Figure 61. Aspen presence forestwide over 5 decades by alternative

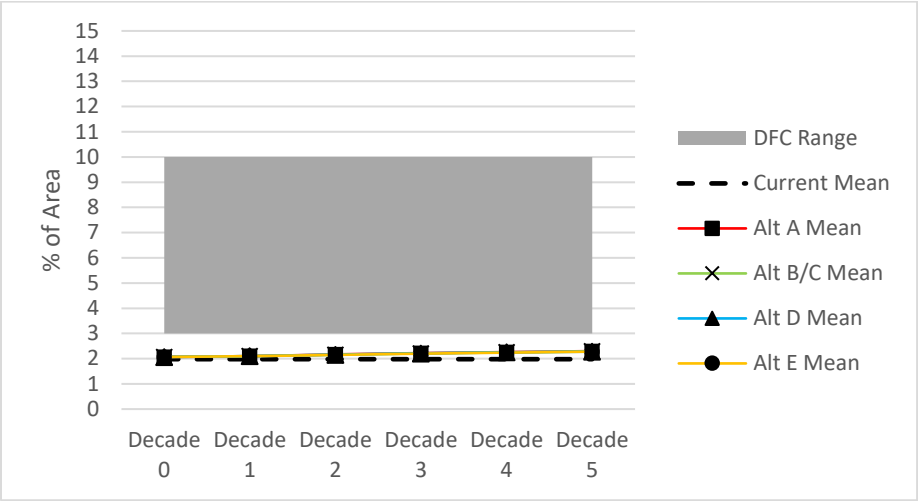


Figure 62. Aspen presence by geographic area, mean at 50 years

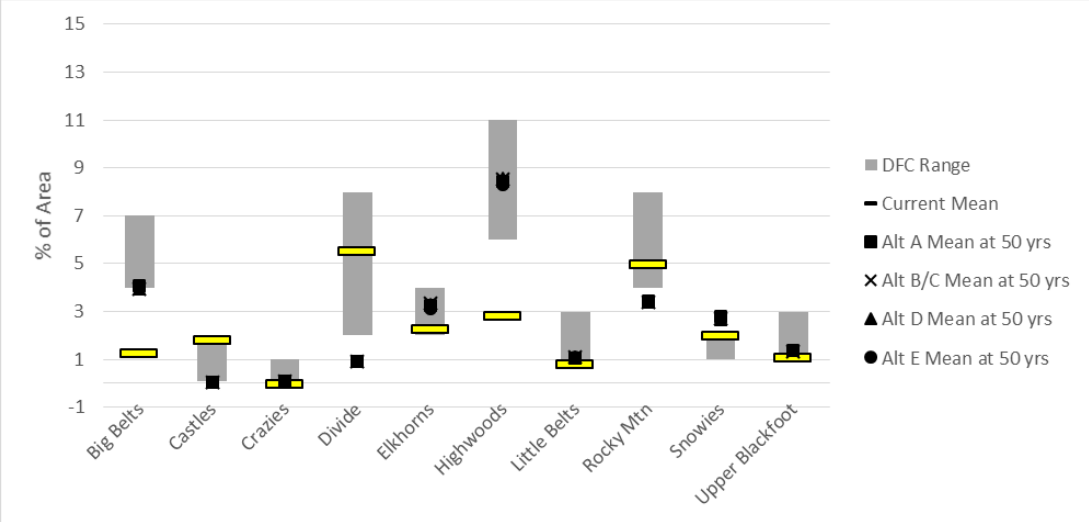


Figure 63. Ponderosa pine presence forestwide over 5 decades by alternative

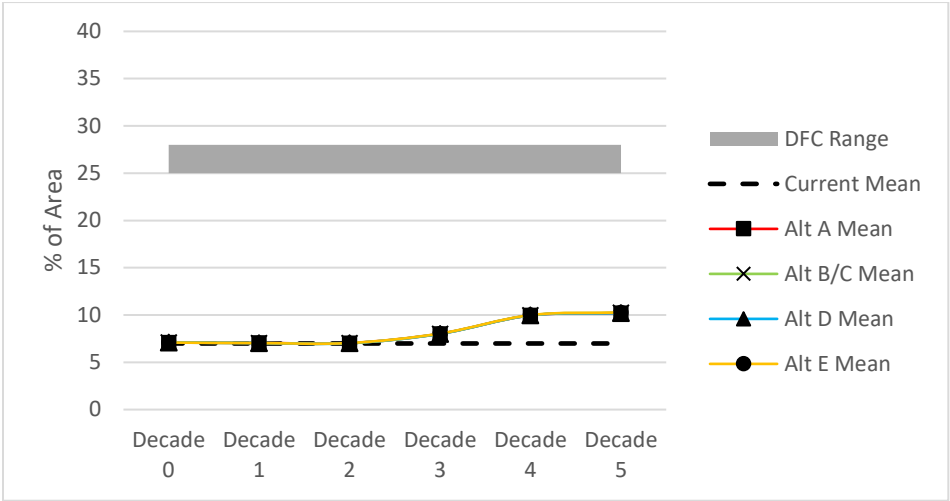


Figure 64. Ponderosa pine presence by geographic area, mean at 50 years

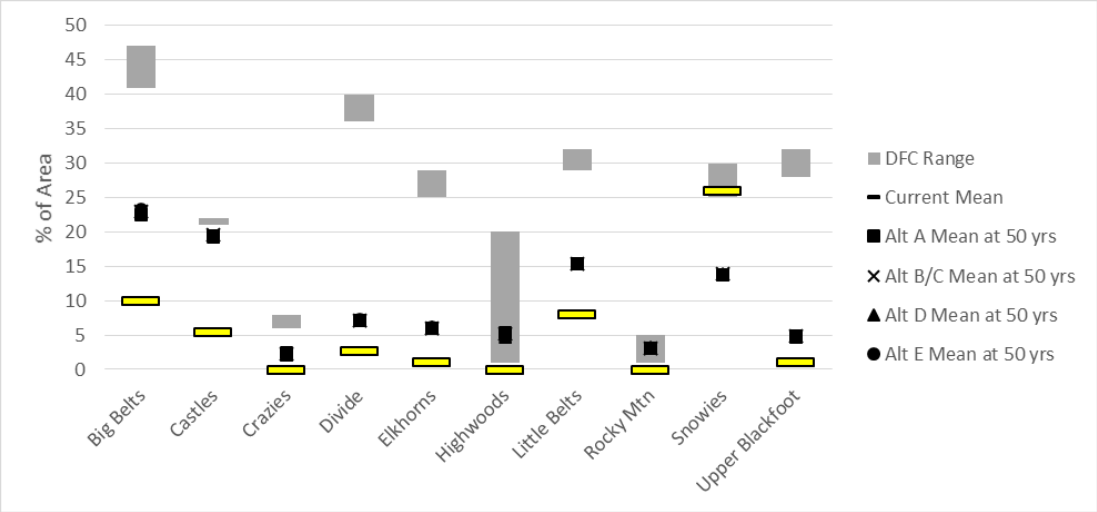


Figure 65. Douglas-fir presence forestwide over 5 decades by alternative

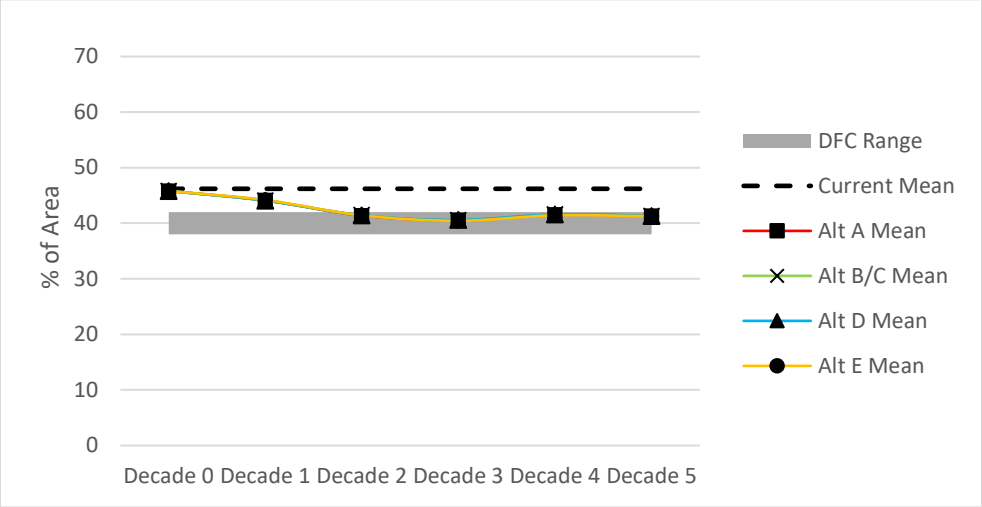


Figure 66. Douglas-fir presence by geographic area, mean at 50 years

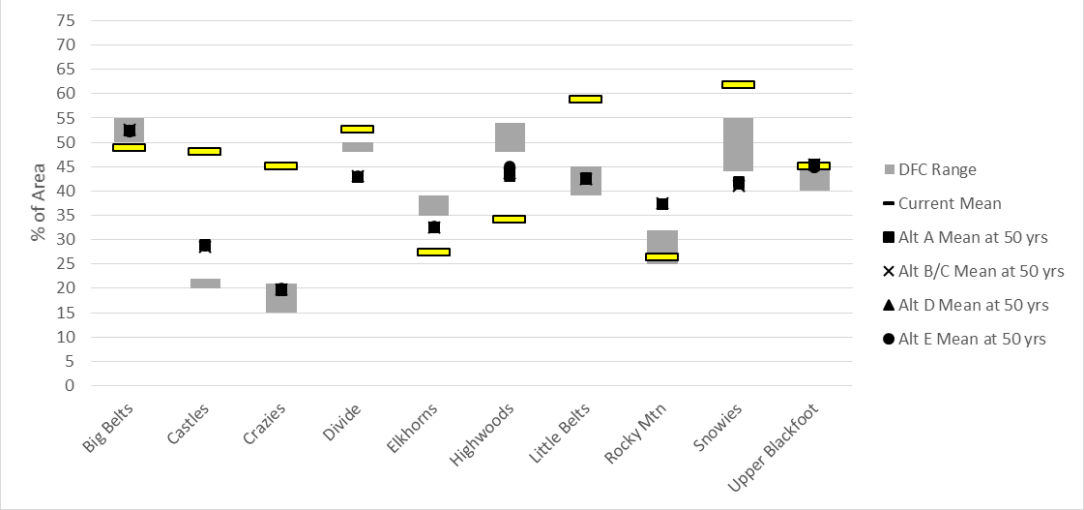


Figure 67. Western larch presence in the Upper Blackfoot GA over 5 decades by alternative

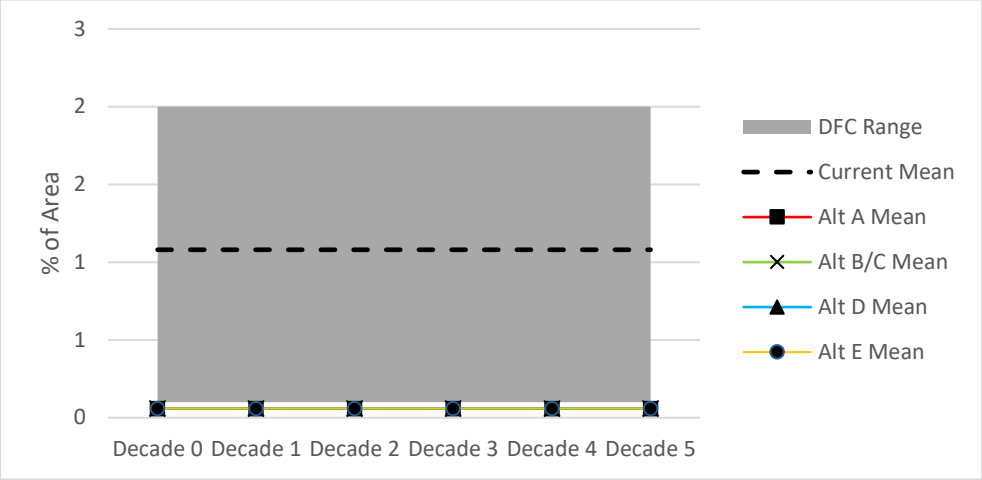


Figure 68. Lodgepole pine presence forestwide over 5 decades by alternative

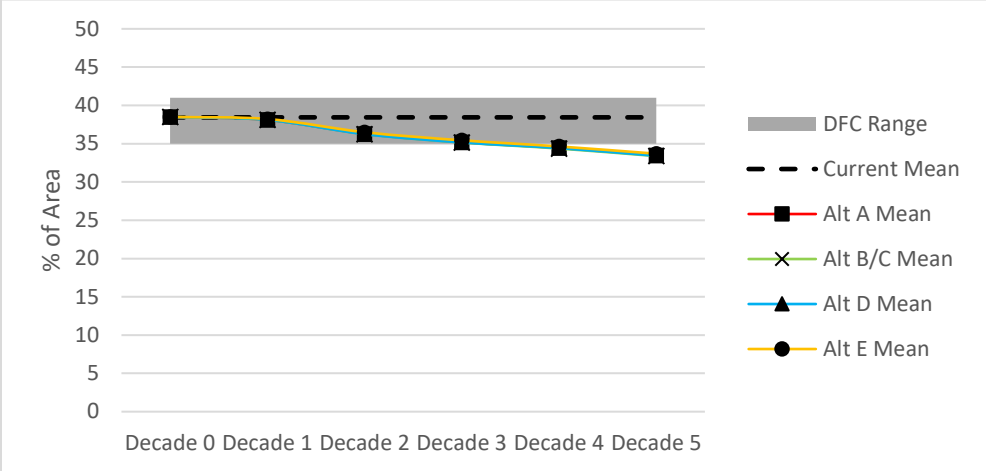


Figure 69. Lodgepole pine presence by geographic area, mean at 50 years

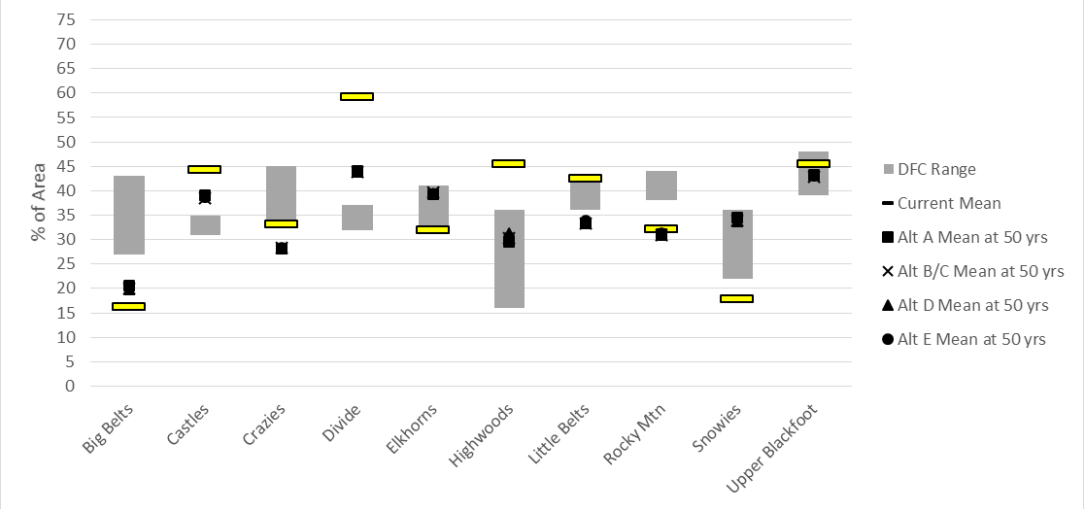


Figure 70. Engelmann spruce presence forestwide over 5 decades by alternative

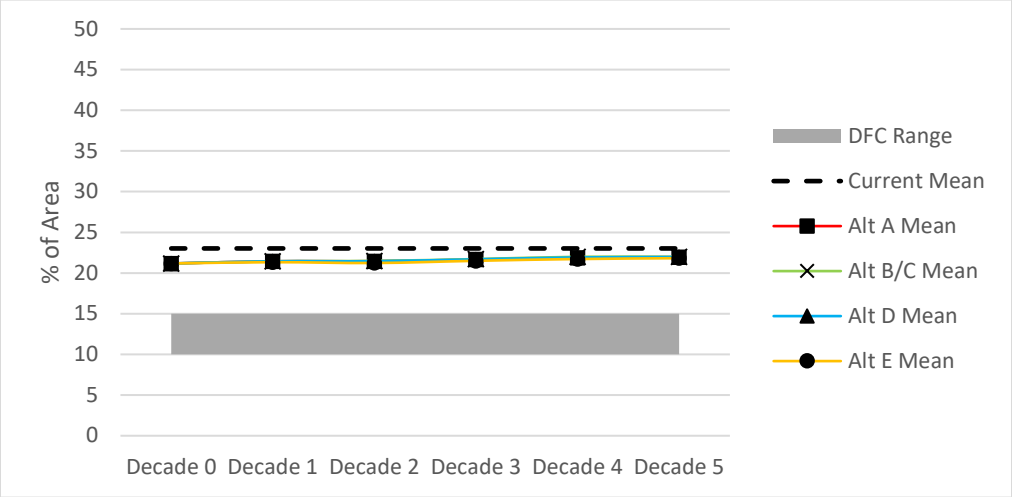


Figure 71. Engelmann spruce presence by geographic area, mean at 50 years

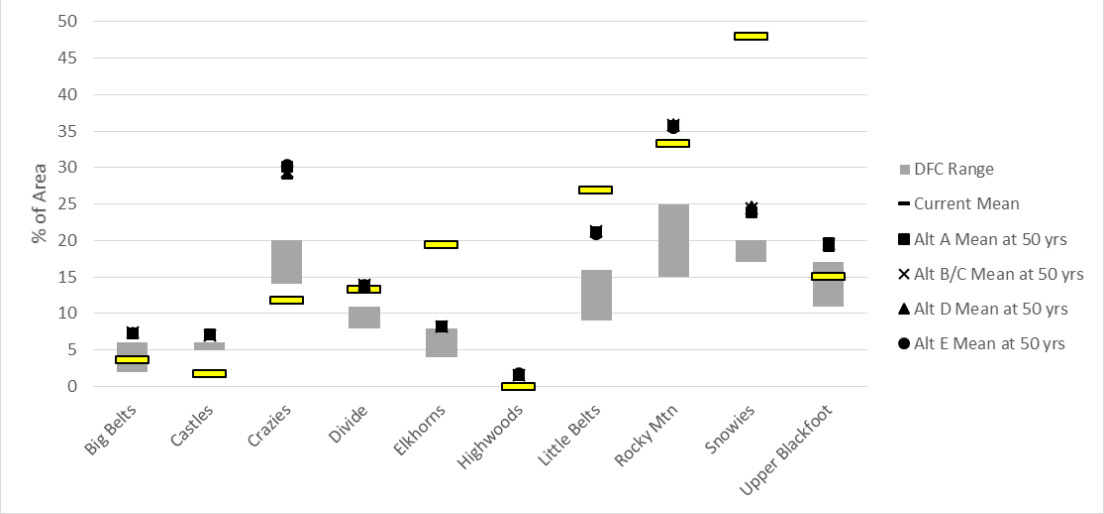


Figure 72. Subalpine fir presence forestwide over 5 decades by alternative

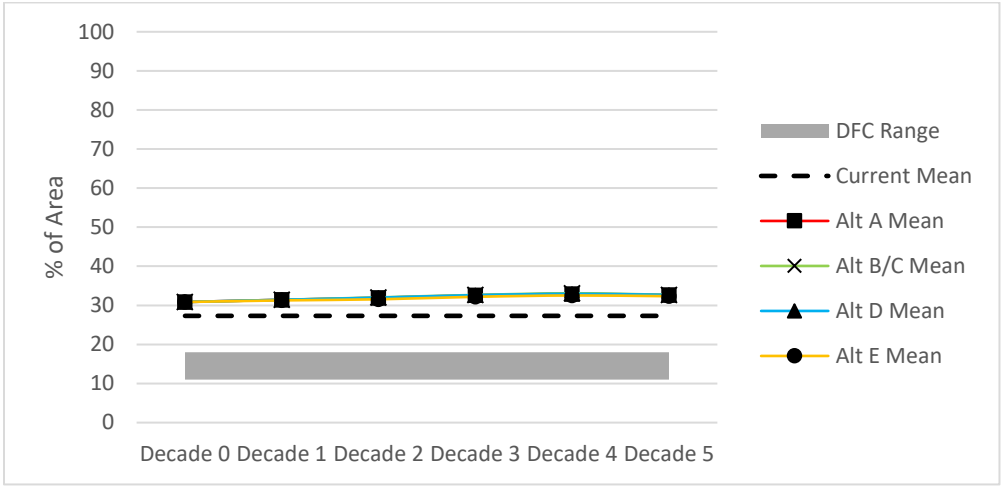


Figure 73. Subalpine fir presence by geographic area, mean at 50 years

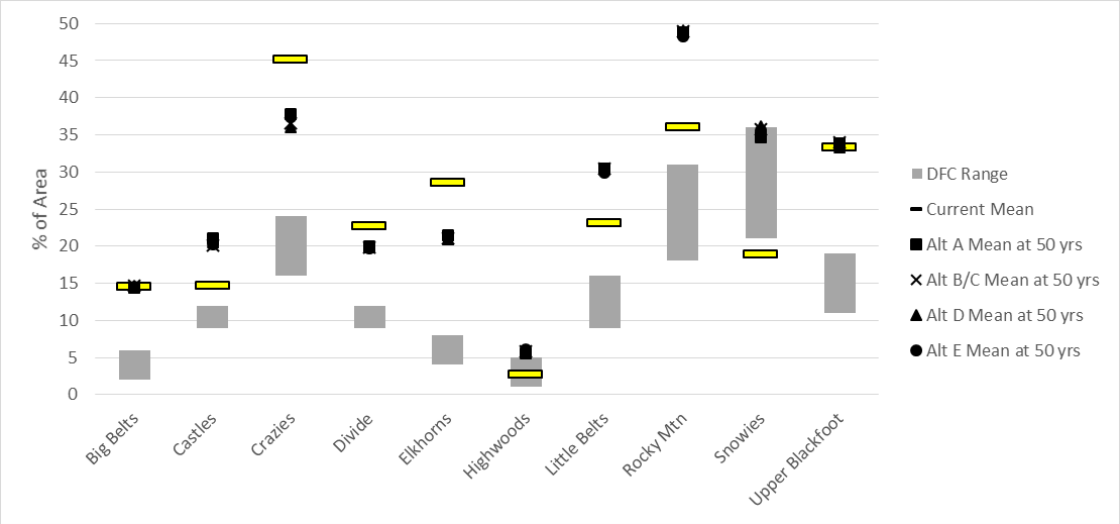


Figure 74. Whitebark pine presence forestwide over 5 decades by alternative

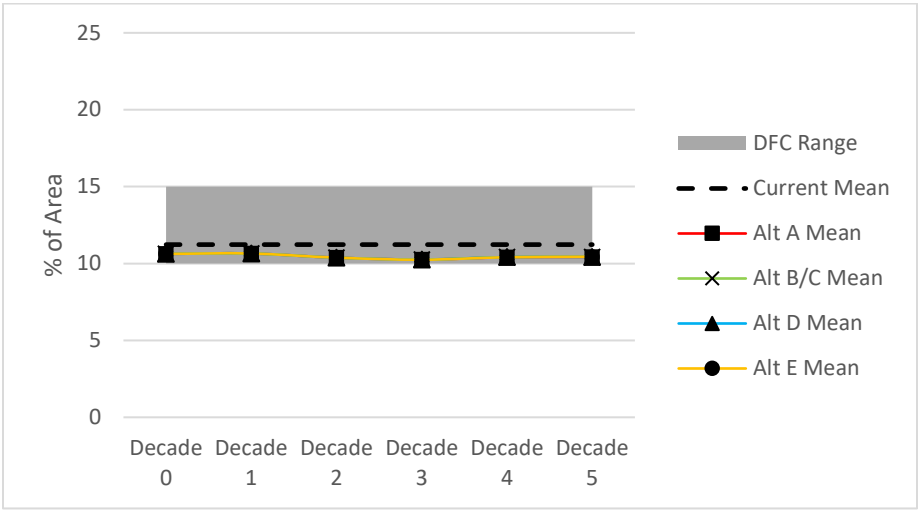


Figure 75. Whitebark pine presence by geographic area, mean at 50 years

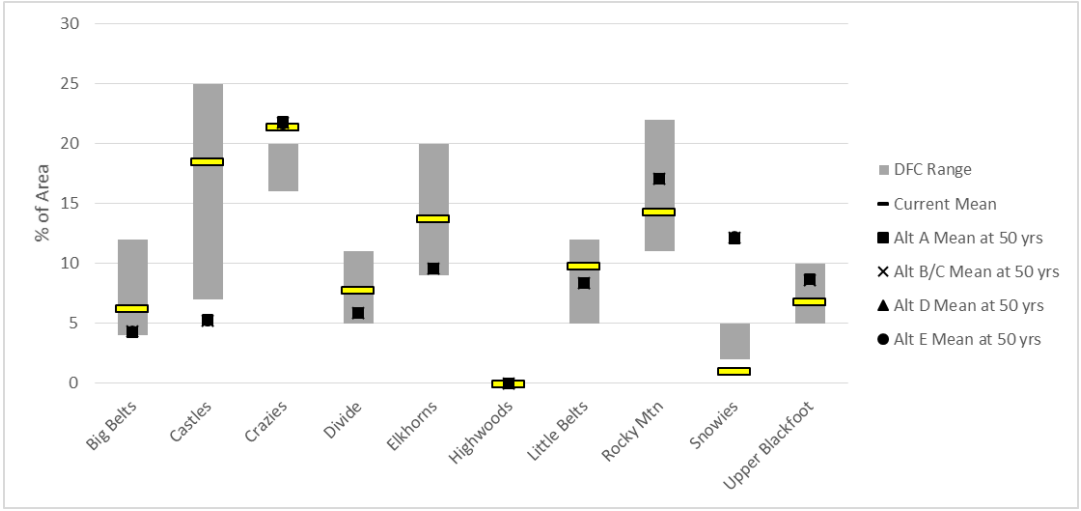


Figure 76. Rocky mountain juniper presence over 5 decades

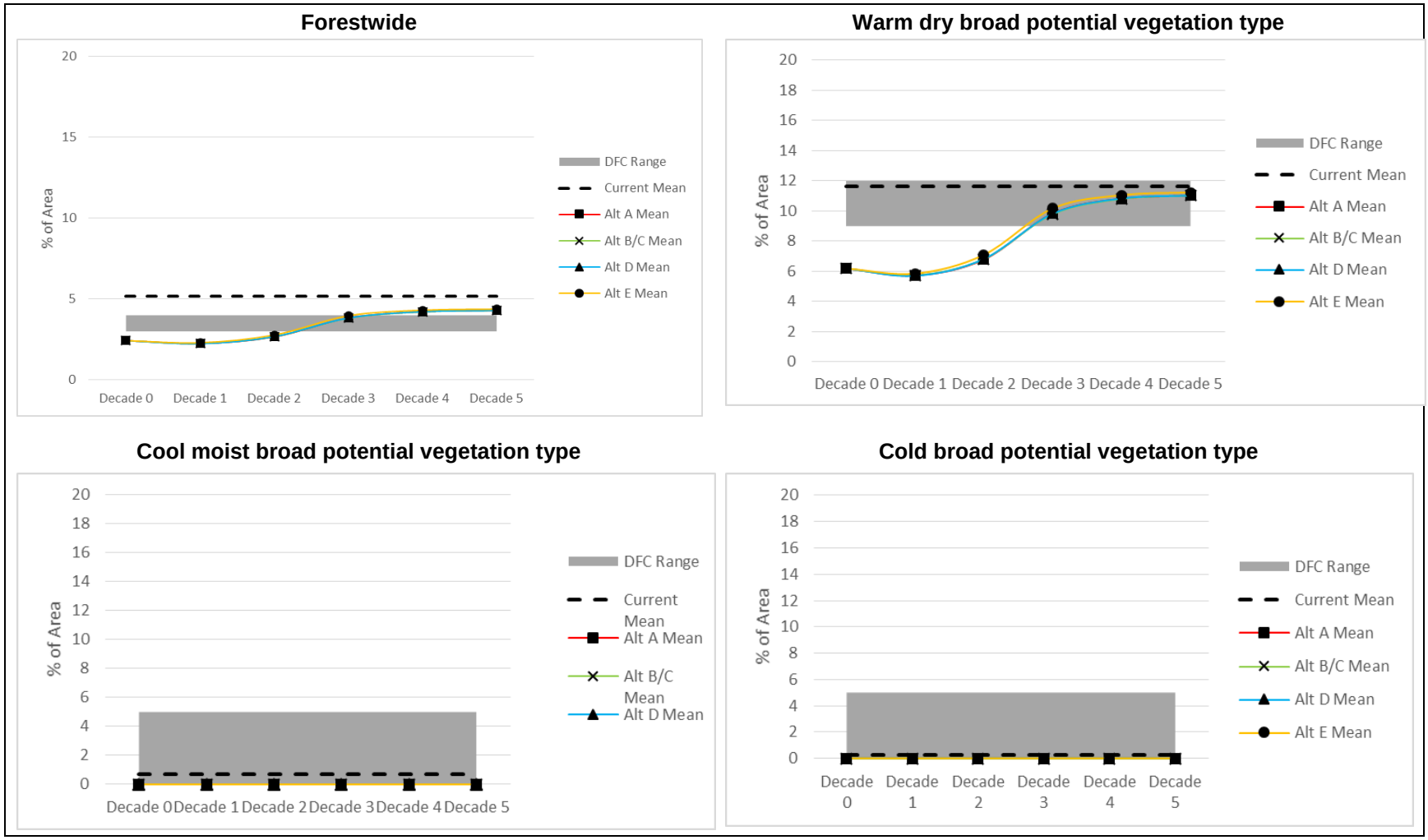


Figure 77. Limber pine presence over 5 decades

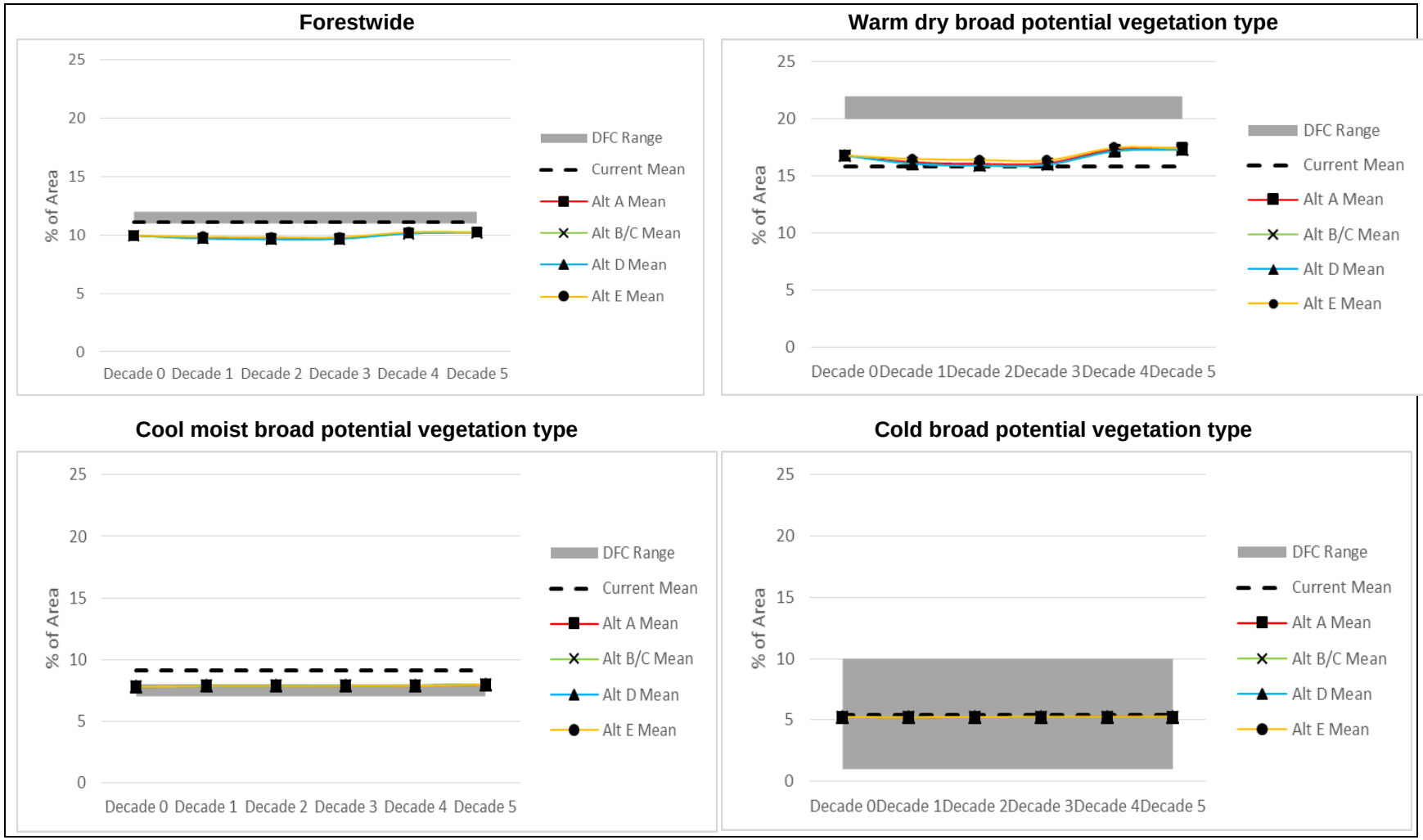


Figure 78. Aspen presence over 5 decades

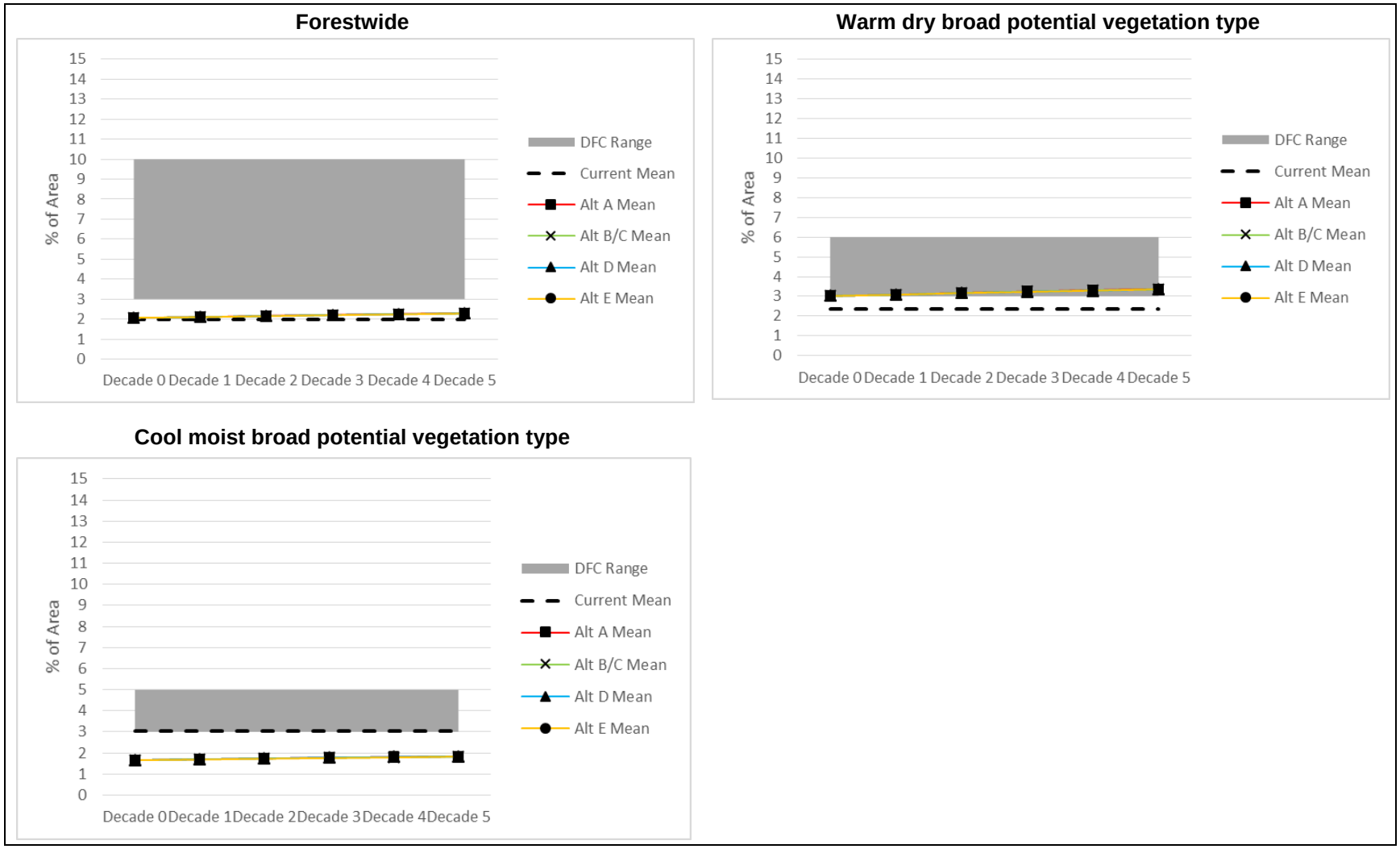


Figure 79. Ponderosa pine presence over 5 decades

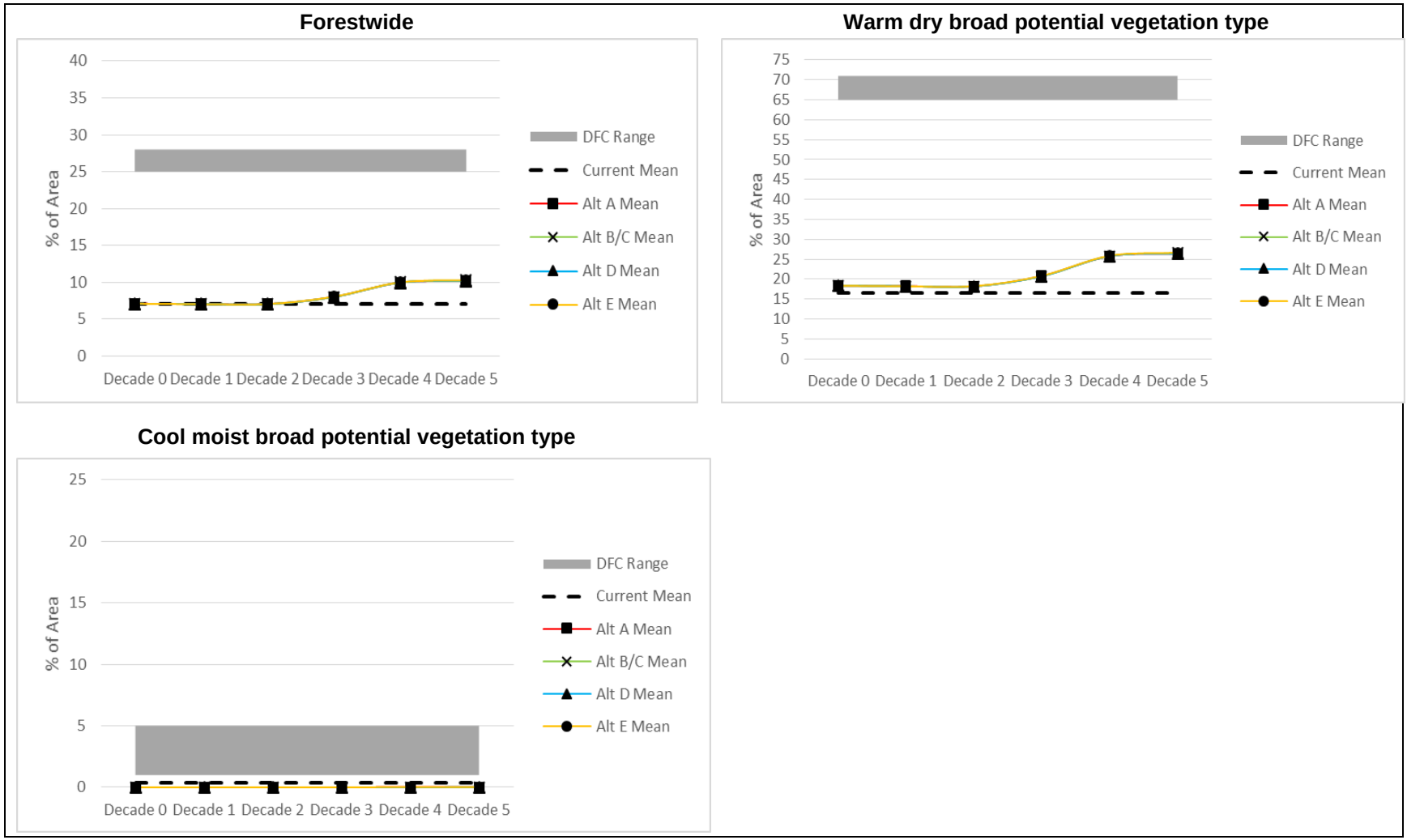


Figure 80. Douglas-fir presence over 5 decades

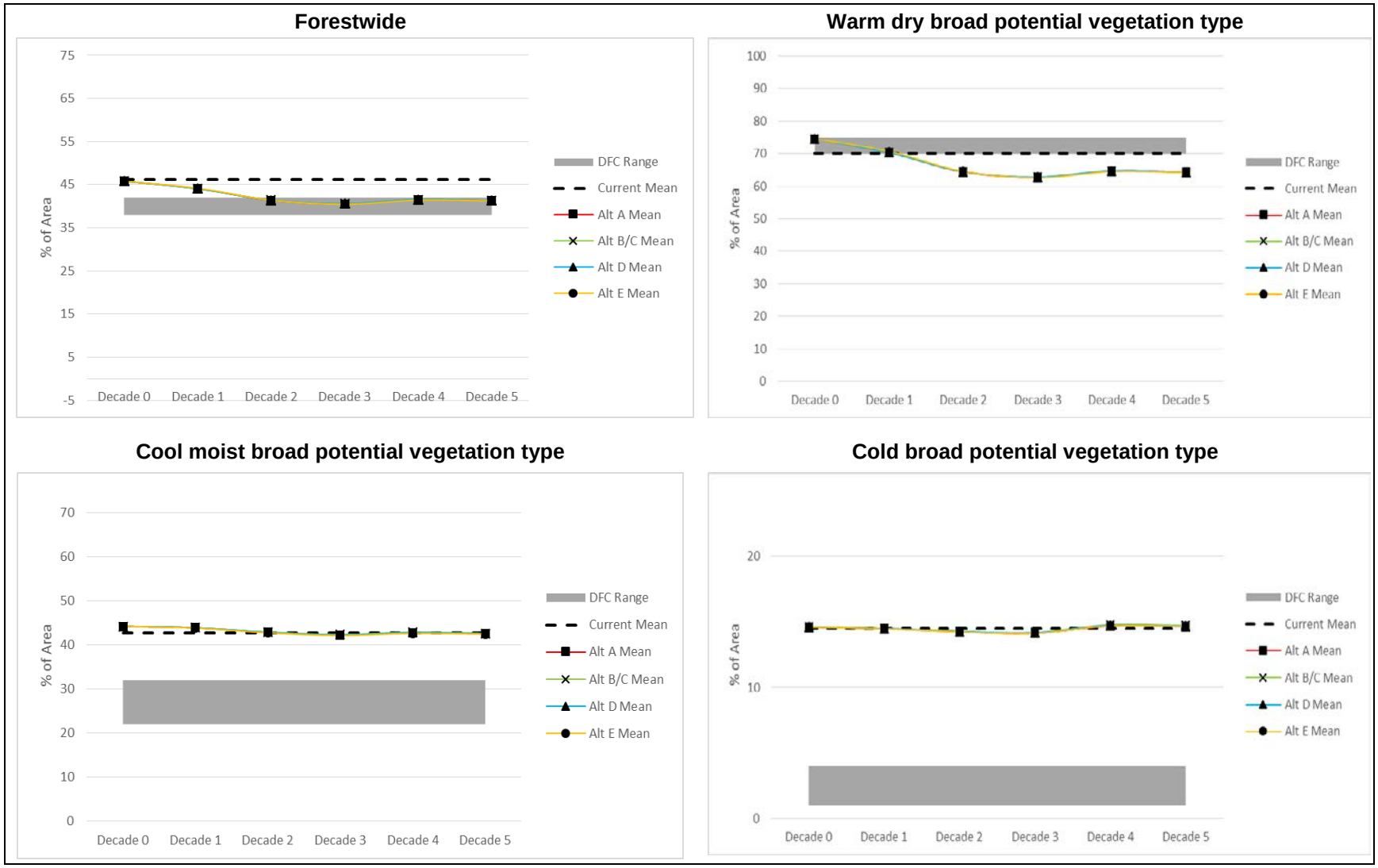


Figure 81. Lodgepole pine presence over 5 decades

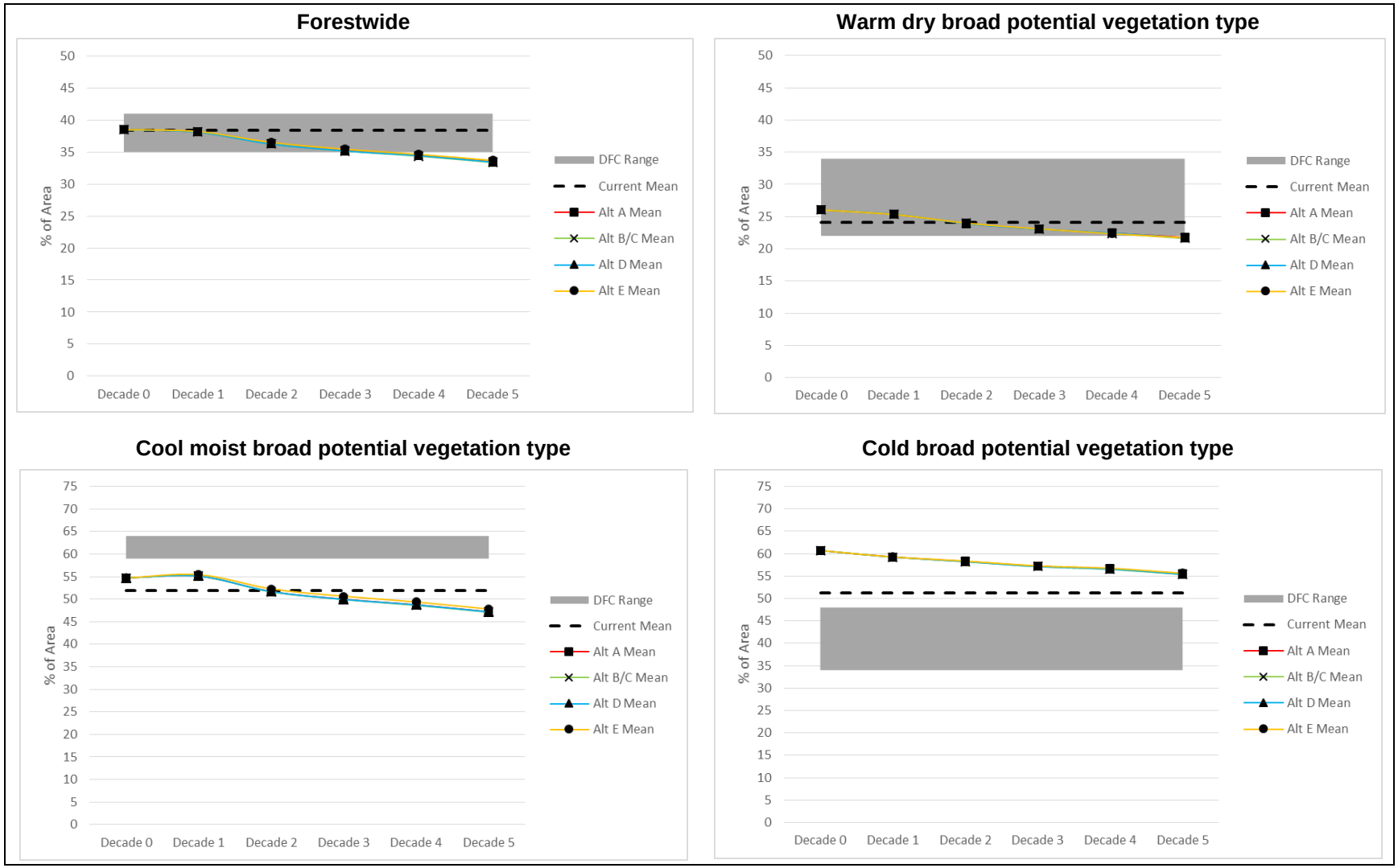


Figure 82. Engelmann spruce presence over 5 decades

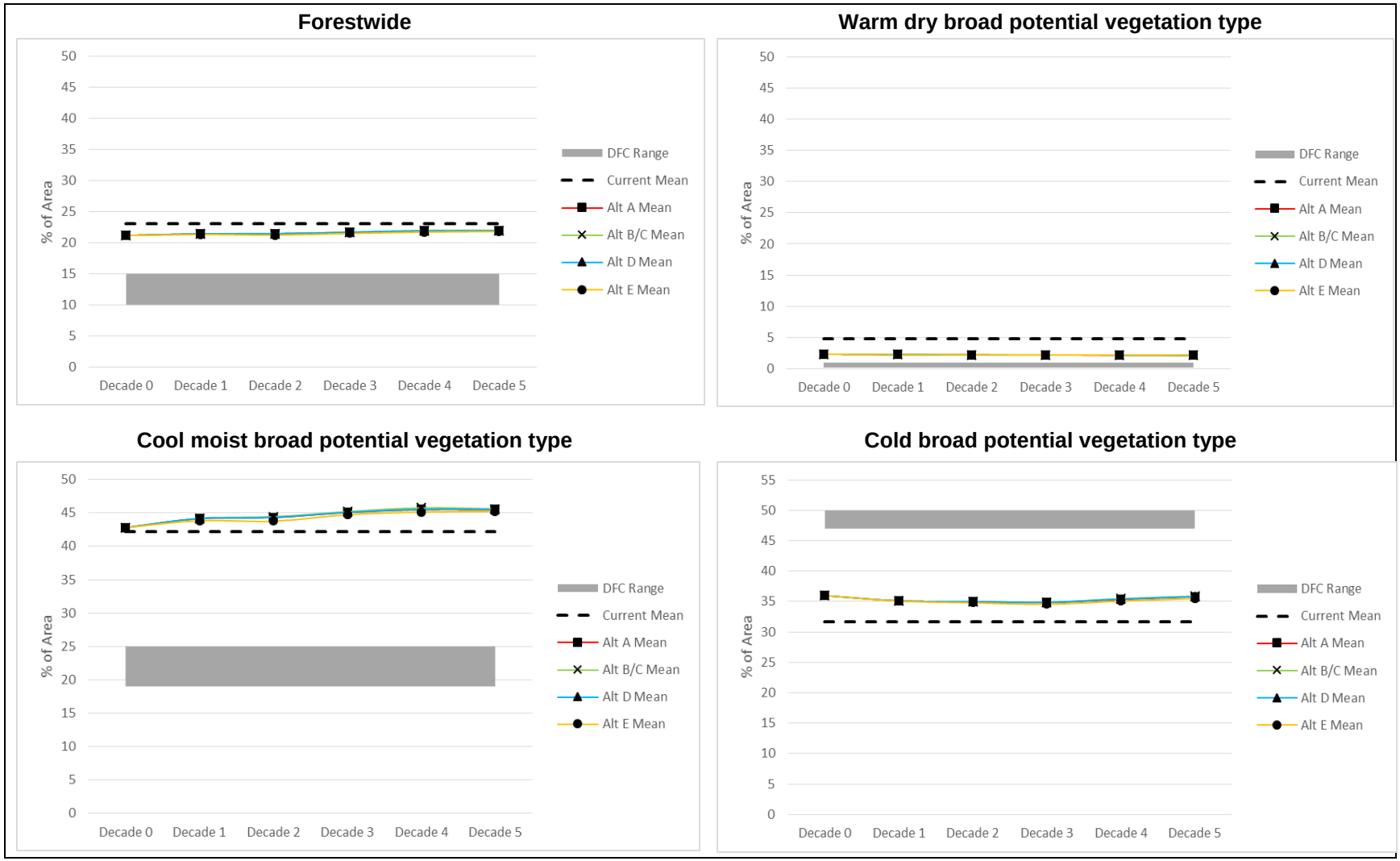


Figure 83. Subalpine fir presence over 5 decades

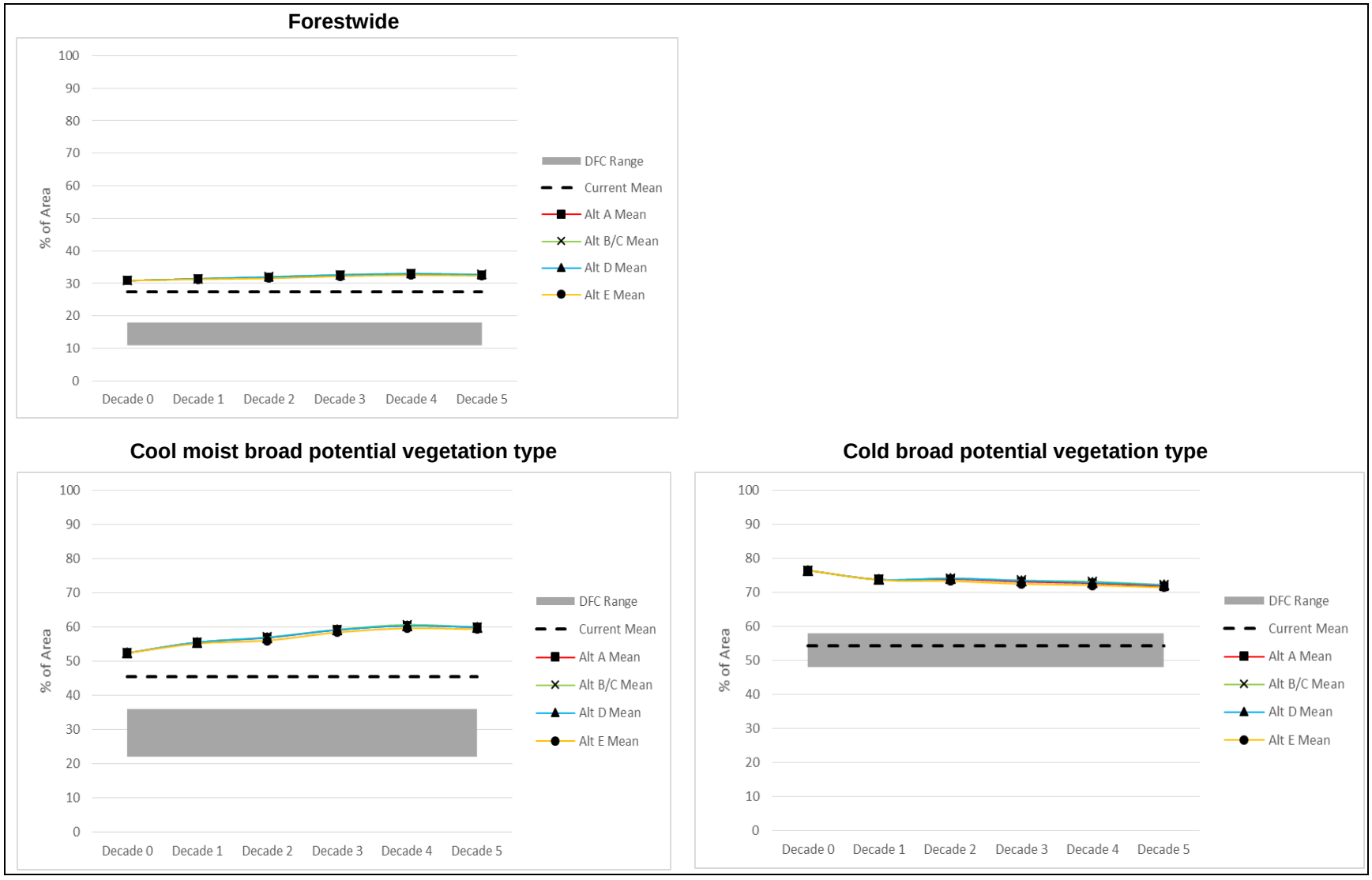
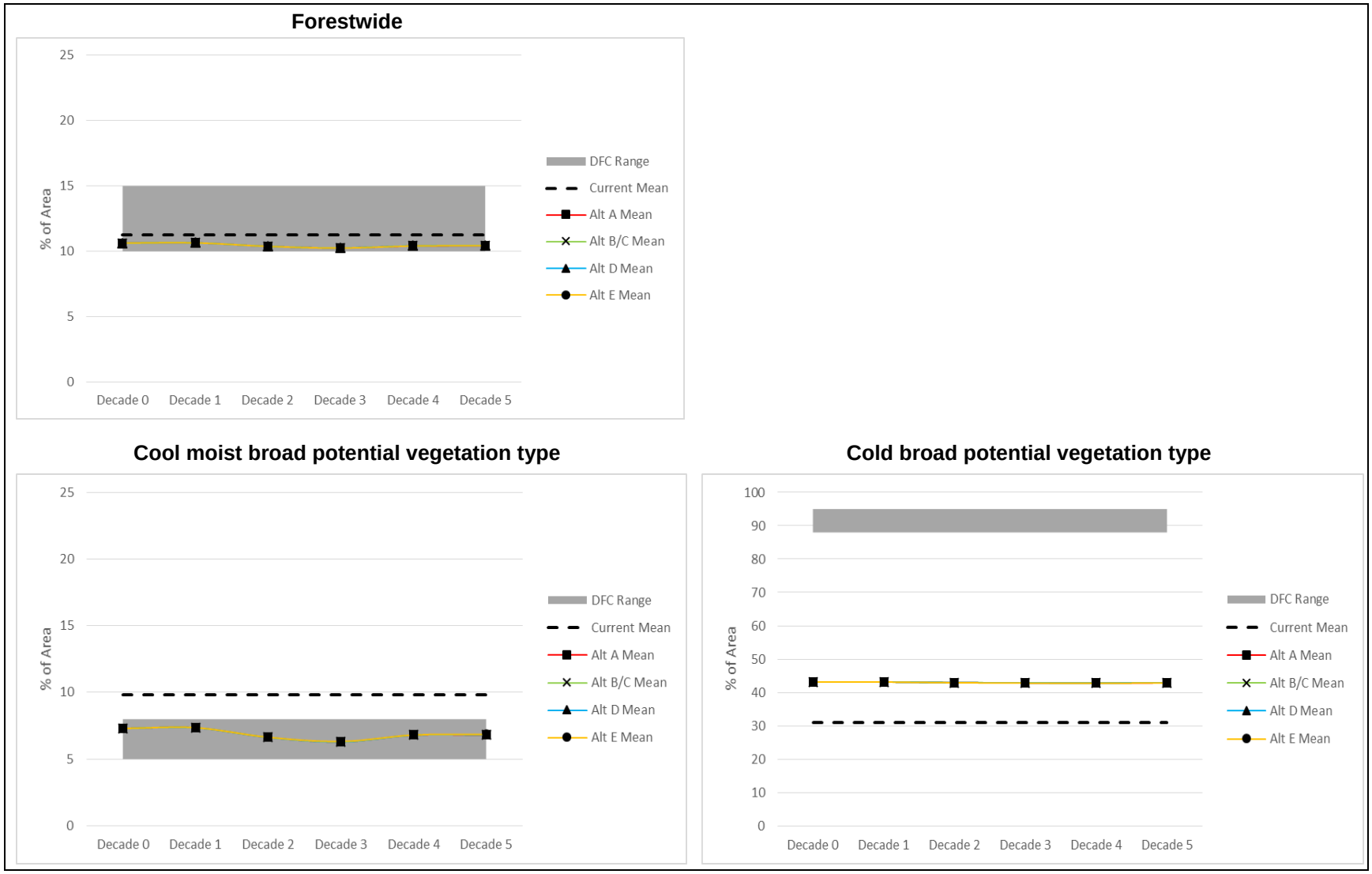


Figure 84. Whitebark pine presence over 5 decades



Forest Size Class, and Large and Very Large Tree Concentrations

The modeled abundance of sizes classes for the 50 year model period are shown forestwide and by broad PVT. In addition, specific results are displayed for several GAs that have desired conditions that vary from the forestwide ranges: the Castles, Crazies, and Highwoods. Areas without size class assigned are excluded; refer to the discussion under nonforested cover types and density classes

The outputs from SIMPPLLE are adjusted proportionately to show outputs that are similar to the classification of size class applied to plot data per the R1 Classification System. This adjustment is done in the same manner as the NRV analysis to develop the desired conditions. The adjustments include increasing the modeled range for seedling/sapling by 5%; increasing small tree by 25%; increasing medium tree by 40%; decreasing large tree by 40%; and decreasing very large tree by 30%. The large and very large size classes projected in SIMPPLLE are analogous to the large and very large tree concentrations as defined in appendix D of the Draft Plan.

Figure 85. Forest size class, forestwide, average conditions at 50 years

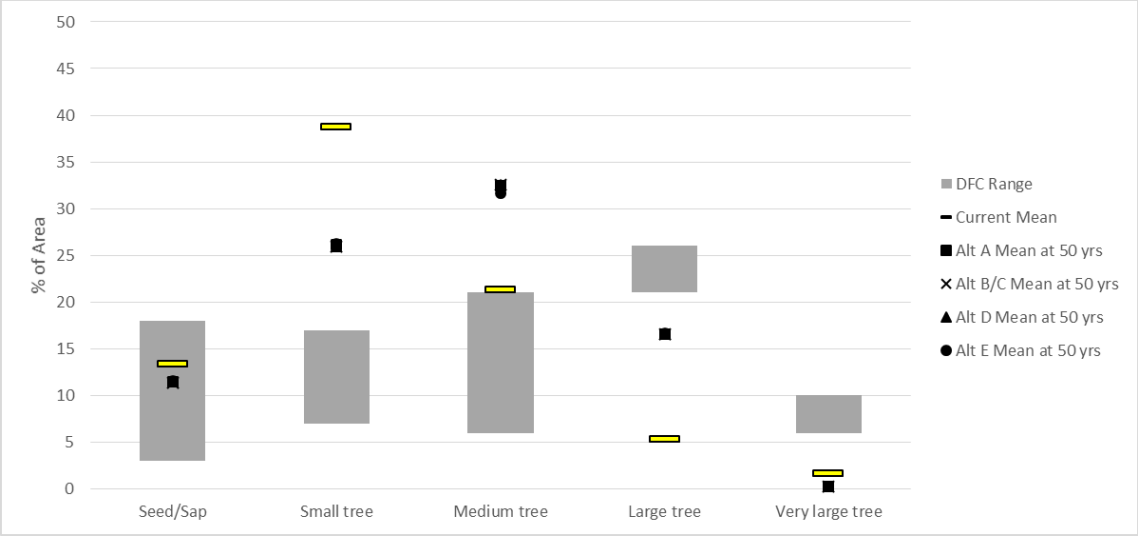


Figure 86. Large and very large tree concentrations, forestwide, average conditions at 50 years

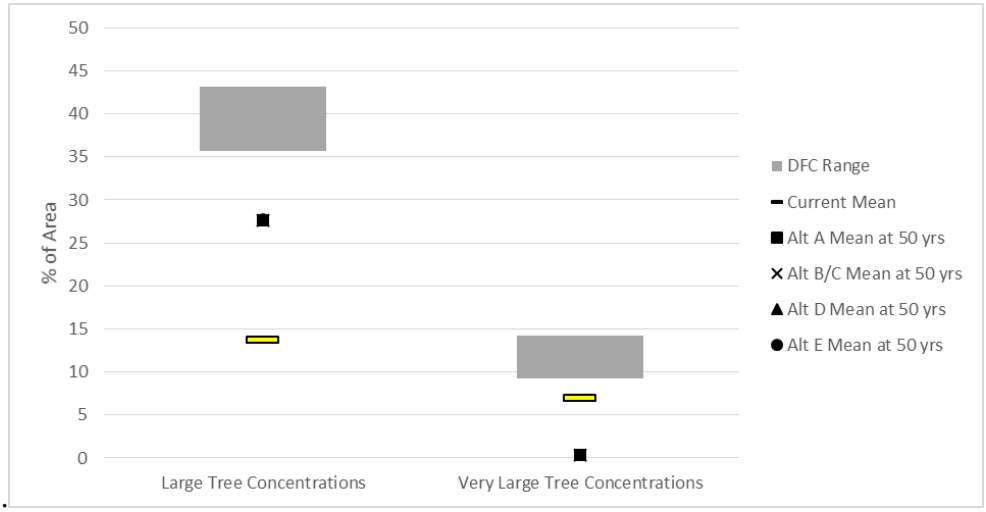


Figure 87. Seedling/sapling size class over 5 decades

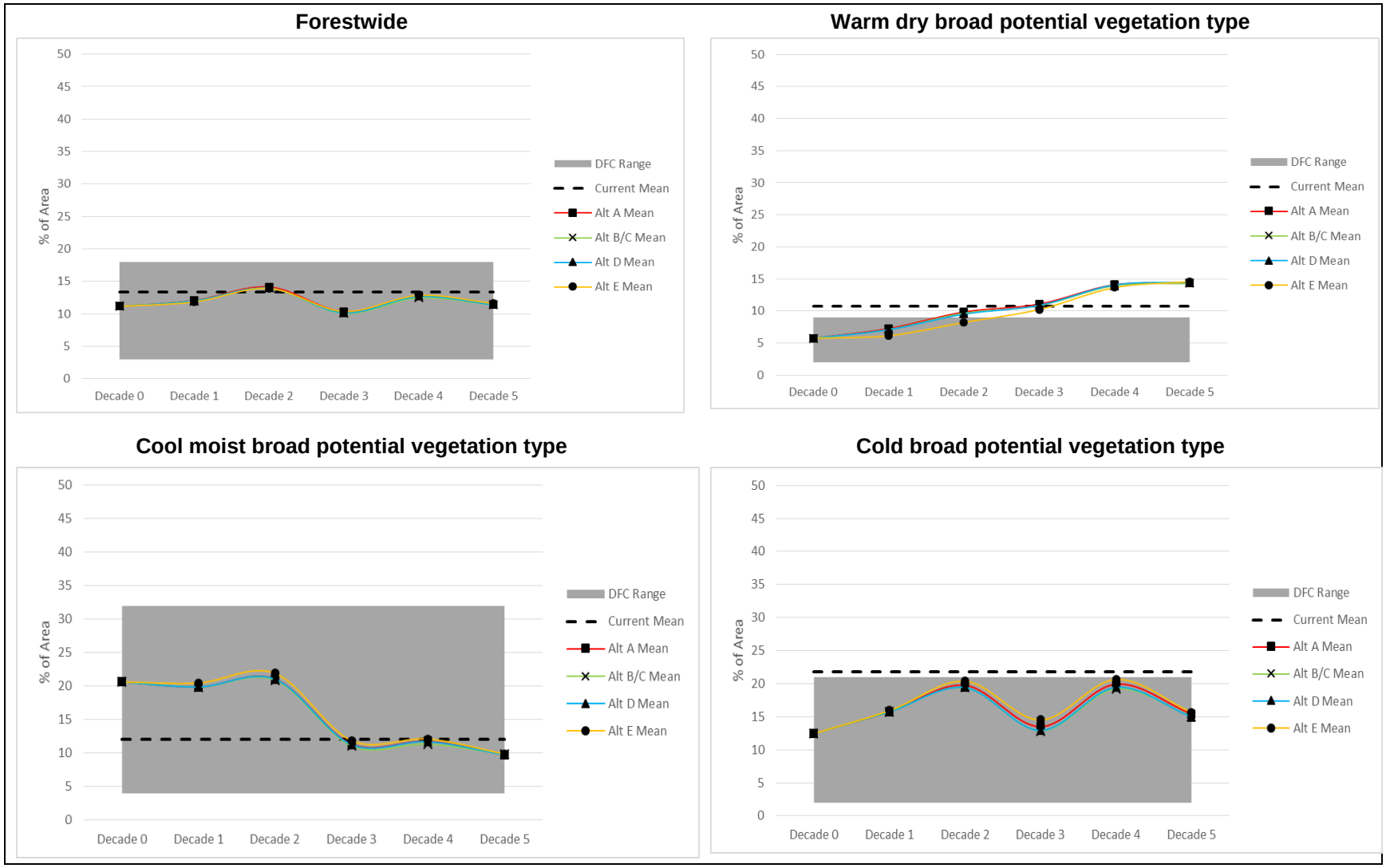


Figure 88. Small tree size class over 5 decades

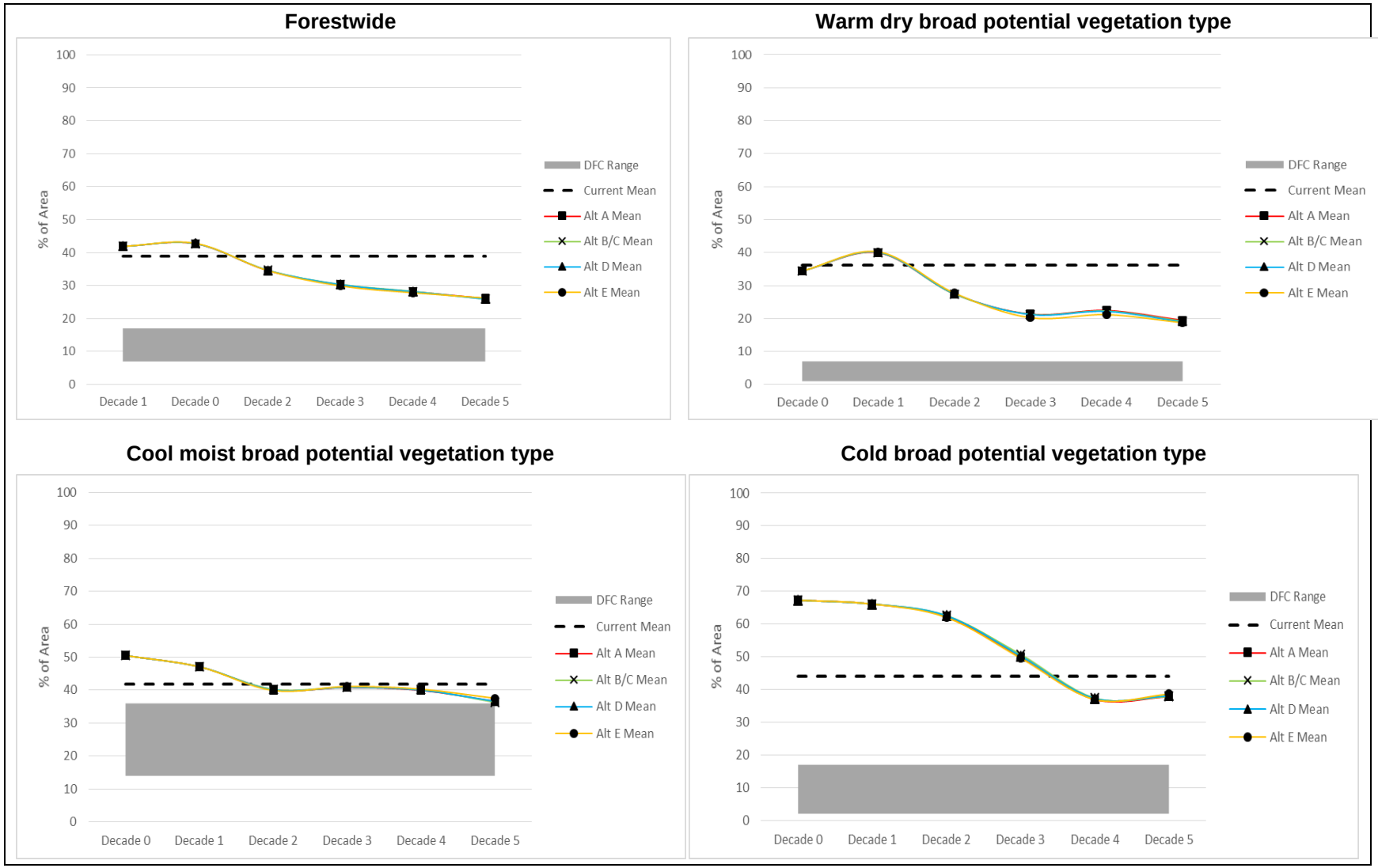


Figure 89. Medium tree size class over 5 decades

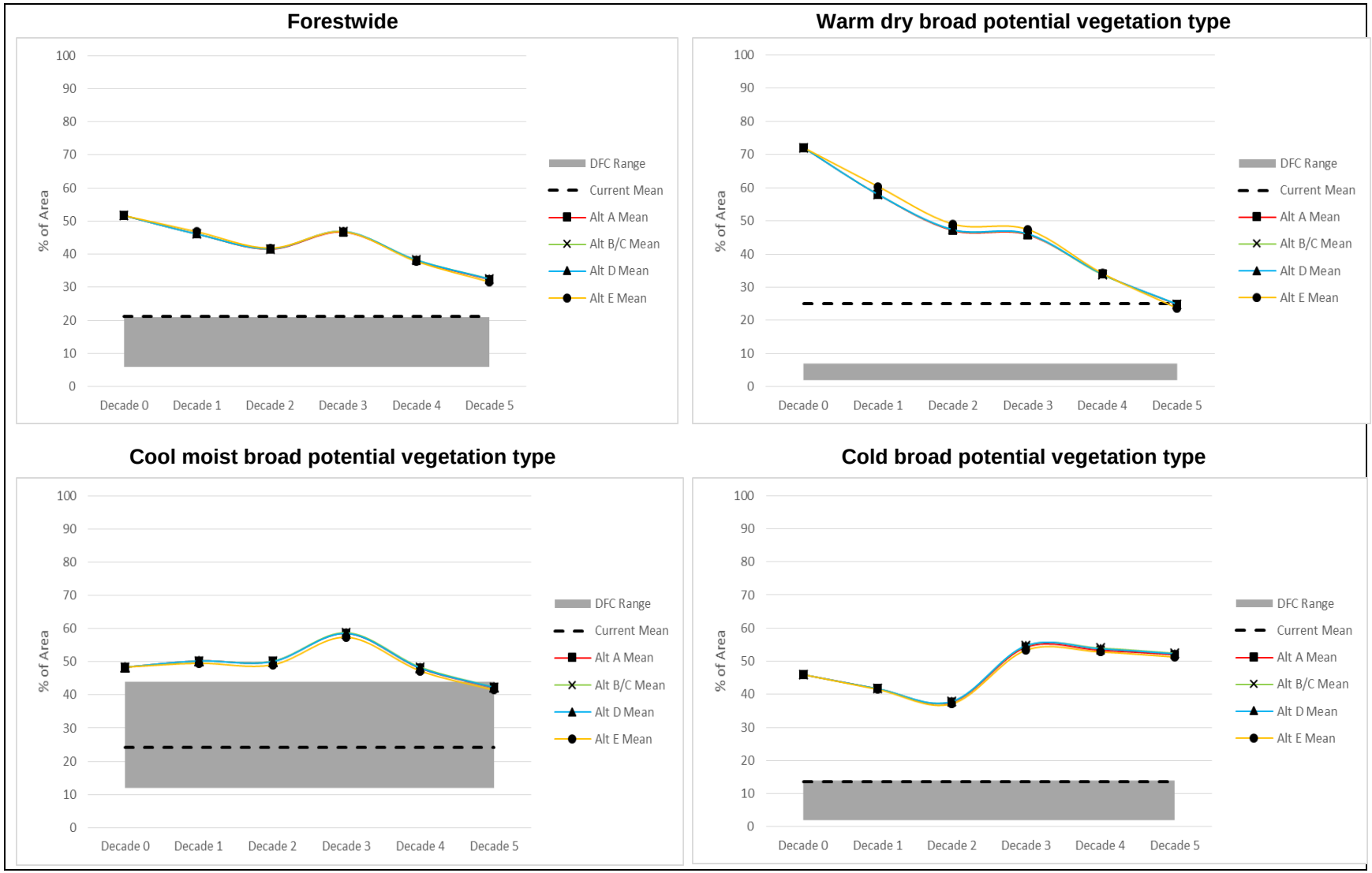


Figure 90. Large tree size class over 5 decades

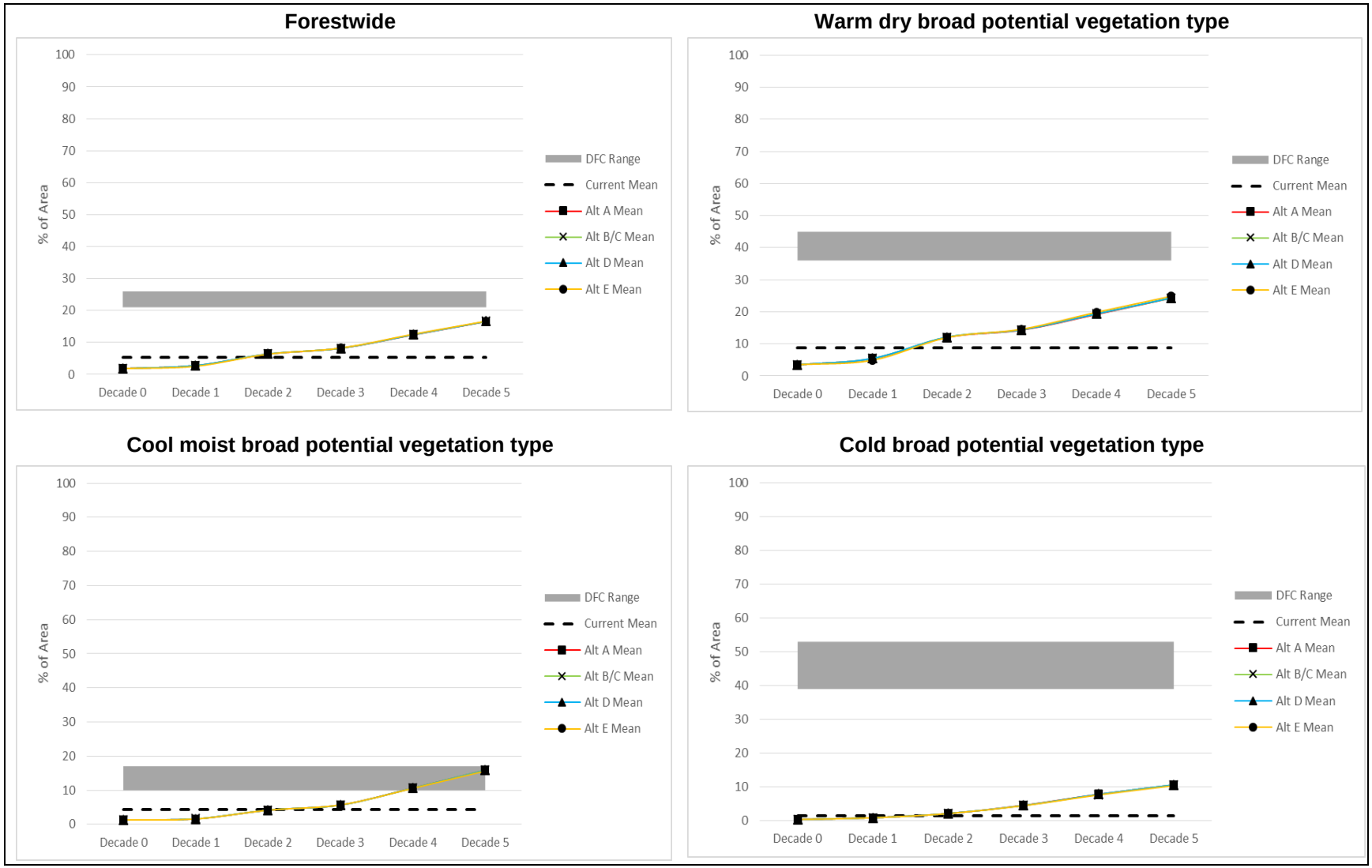


Figure 91. Very large tree size class over 5 decades

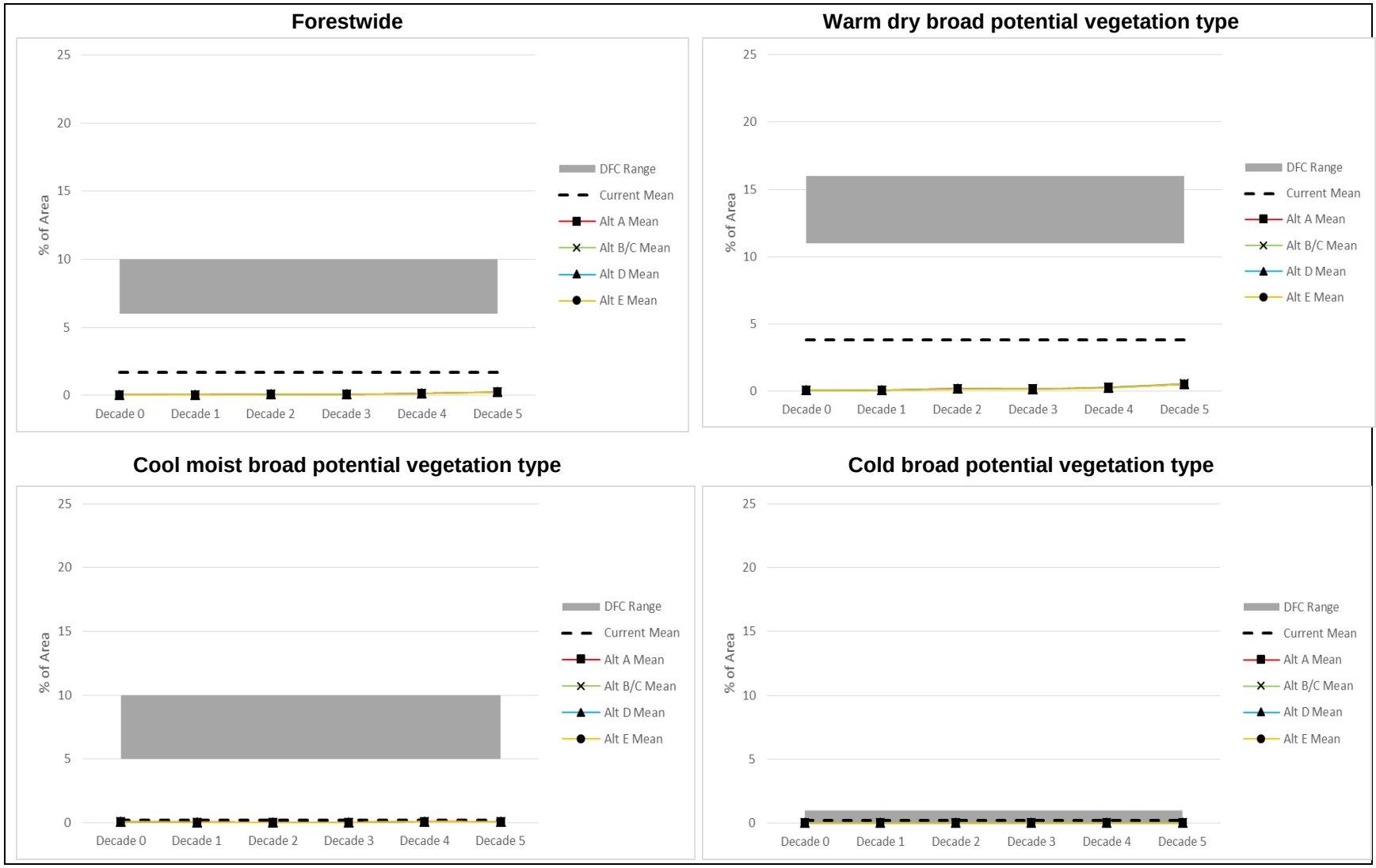


Figure 92. GA-specific size class results

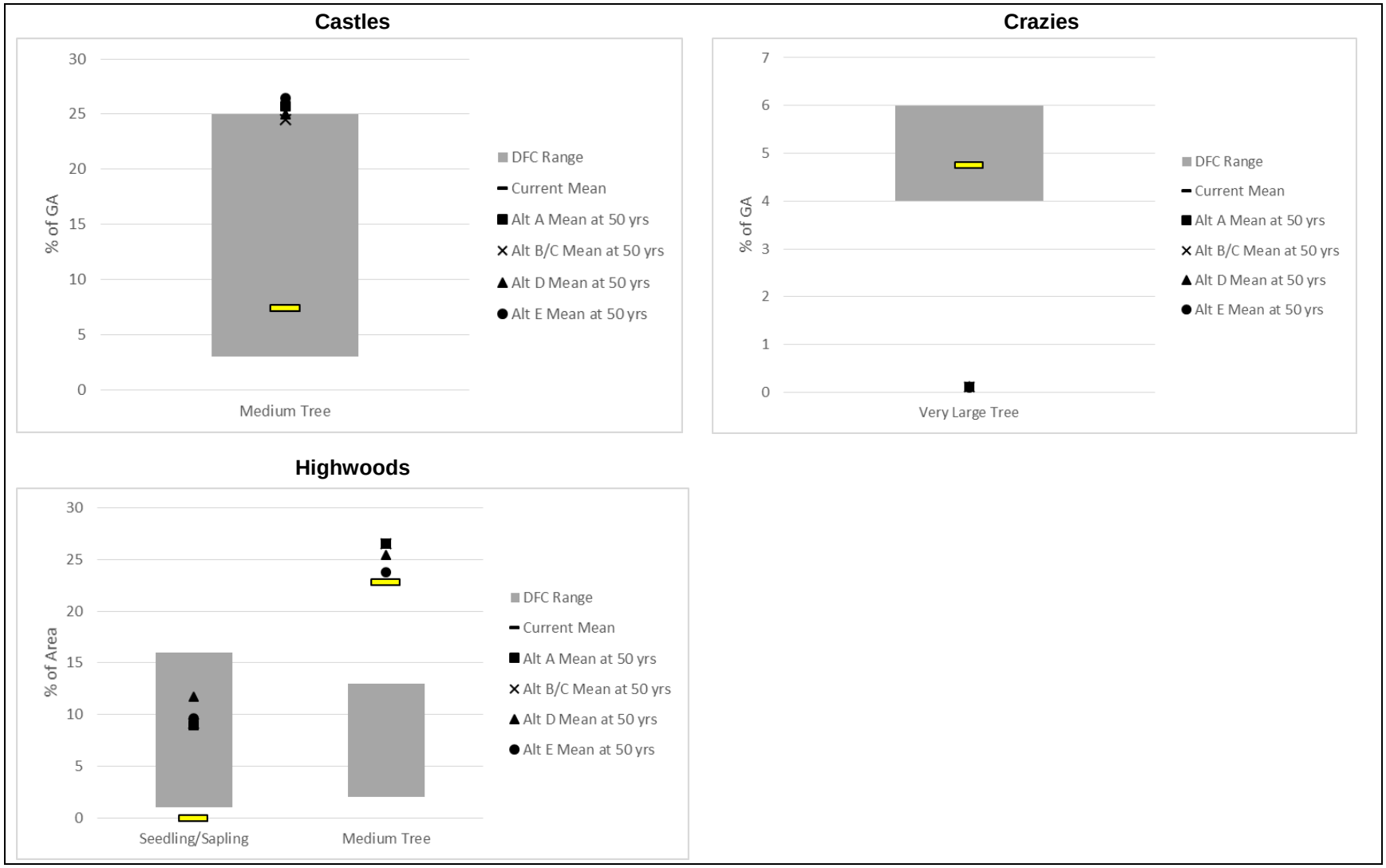


Figure 93. Large tree concentrations over 5 decades

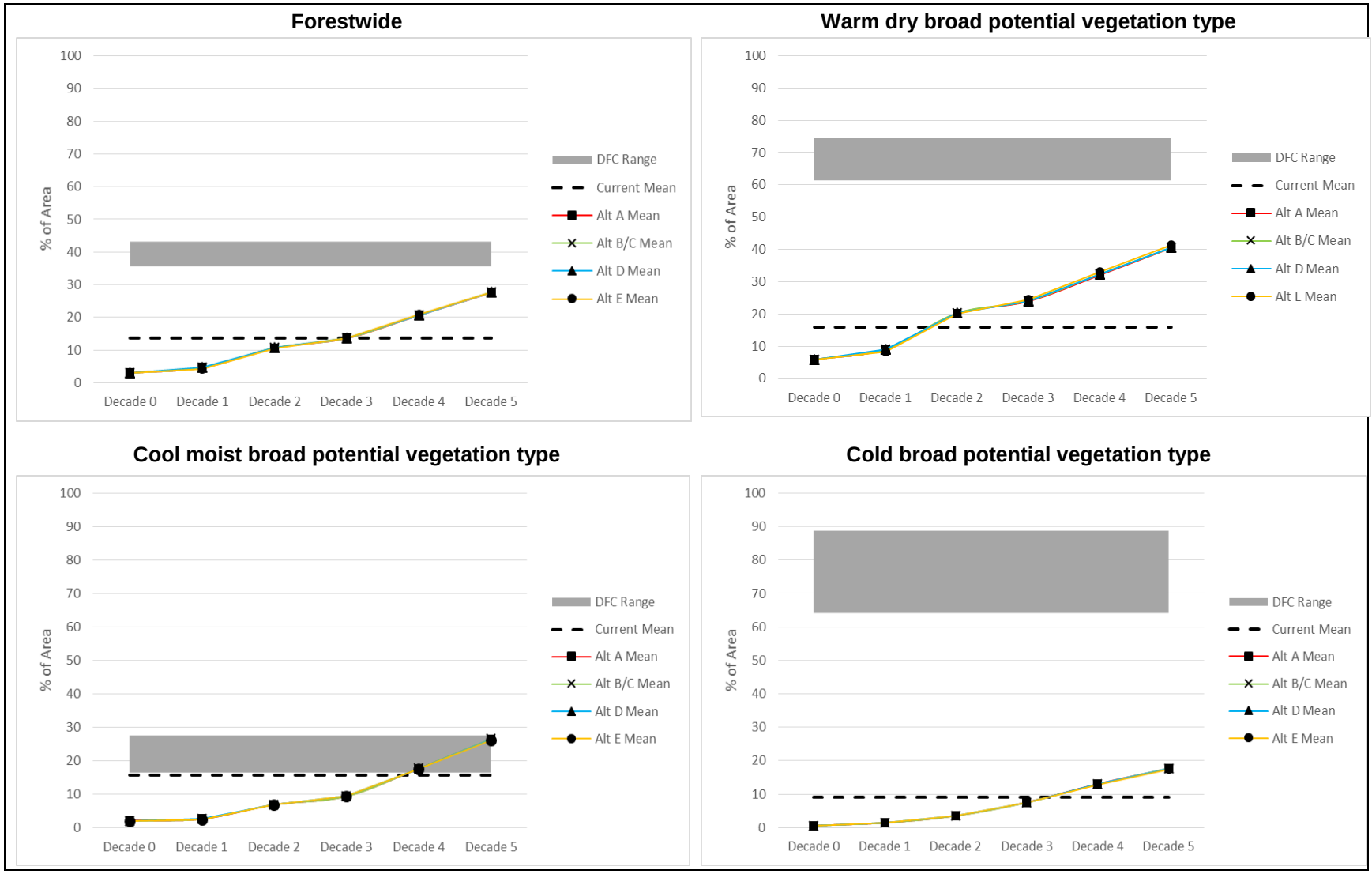
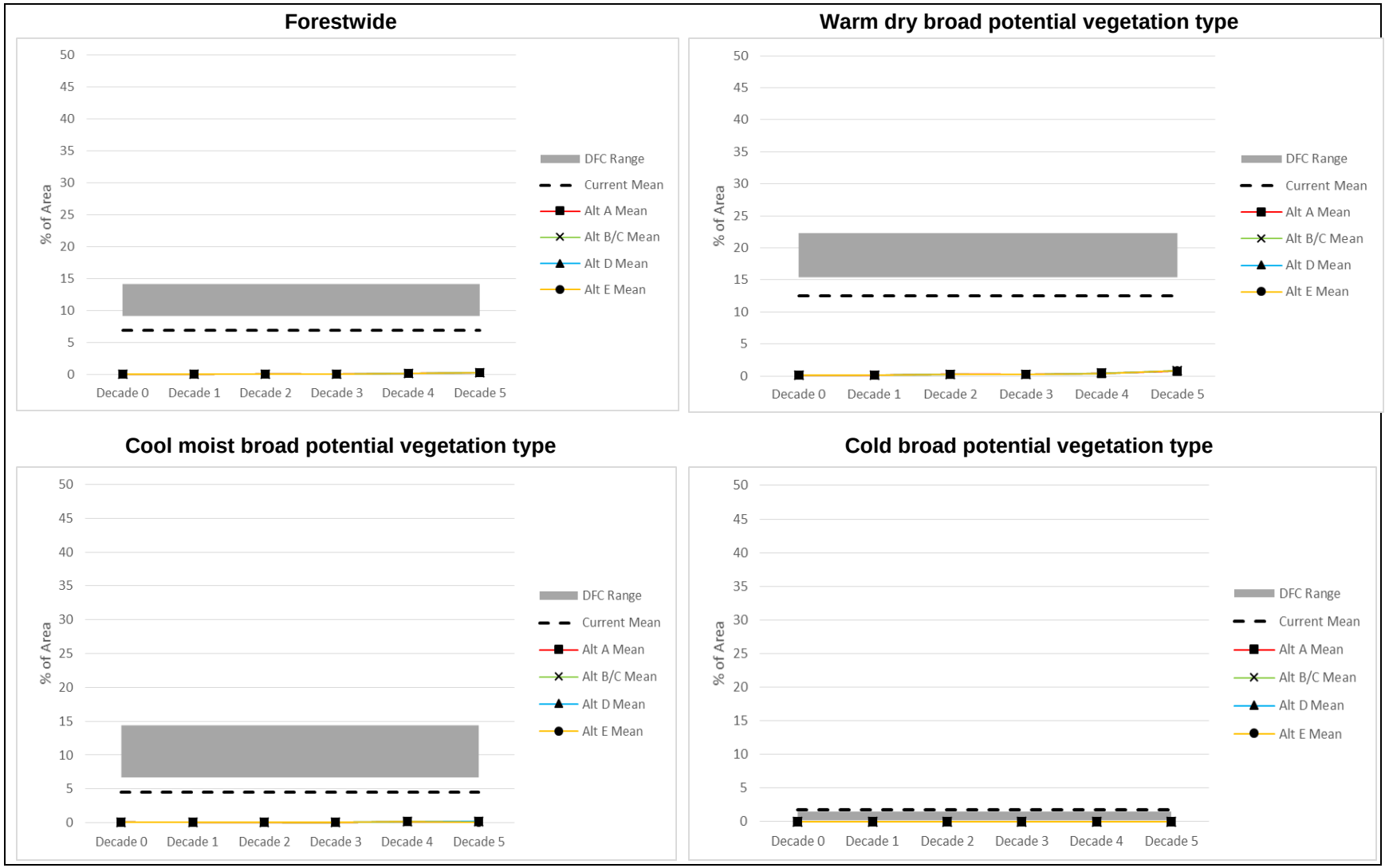


Figure 94. Very large tree concentrations over 5 decades



Forest Density Class

The modeled abundance of density classes for the 50 year model period are shown below. Results are shown forestwide and by broad PVT. There were no specific results for GAs with desired conditions that vary from the forestwide ranges.

Areas are considered non-forested or do not have a density class assigned when there is less than 10% canopy cover of trees present. This includes true grass and shrublands with 0-5% canopy cover, open forest savannas with 5-10% canopy cover, and recently disturbed areas where reforestation has not yet occurred. Refer to the nonforested cover type summaries; note that there are more areas considered non-forested for the purposes of density class than there are for cover type. That is, there are some forest cover types that do not have a density class – most likely, the differences between these classifications represent forest savannas with very open spacing of trees. The existing abundance of nonforested cover types is approximately 14% forestwide, while the abundance of the nonforest/none density class is 22%, indicating that at least roughly 8% of the forest is in a very open forested condition.

Figure 95. Summary of forest density class, forestwide, average conditions at 50 years

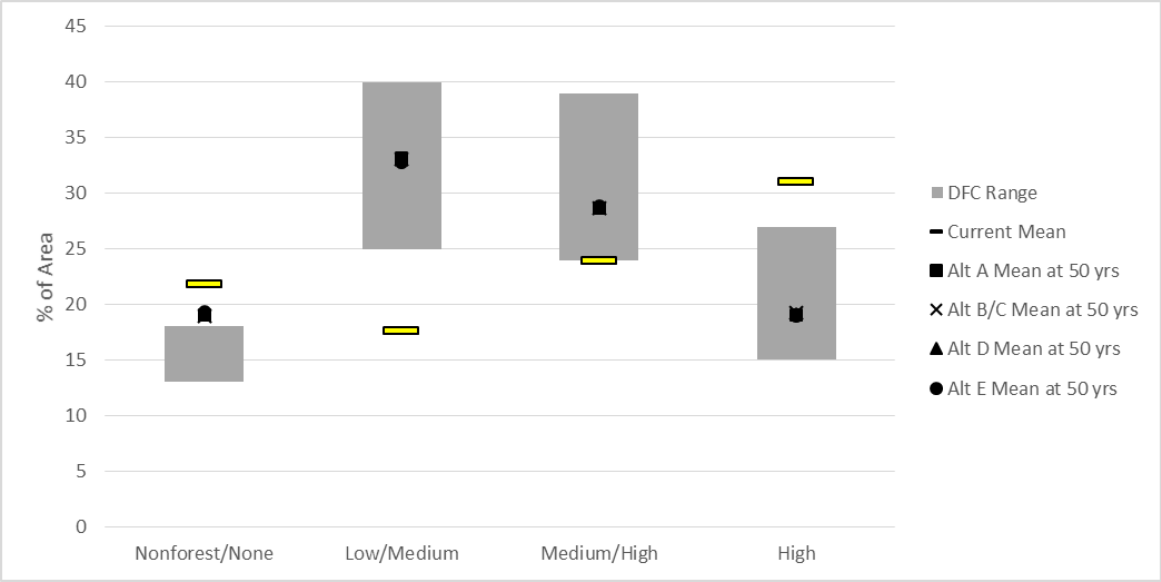


Figure 96. Nonforest/None forest density class over 5 decades

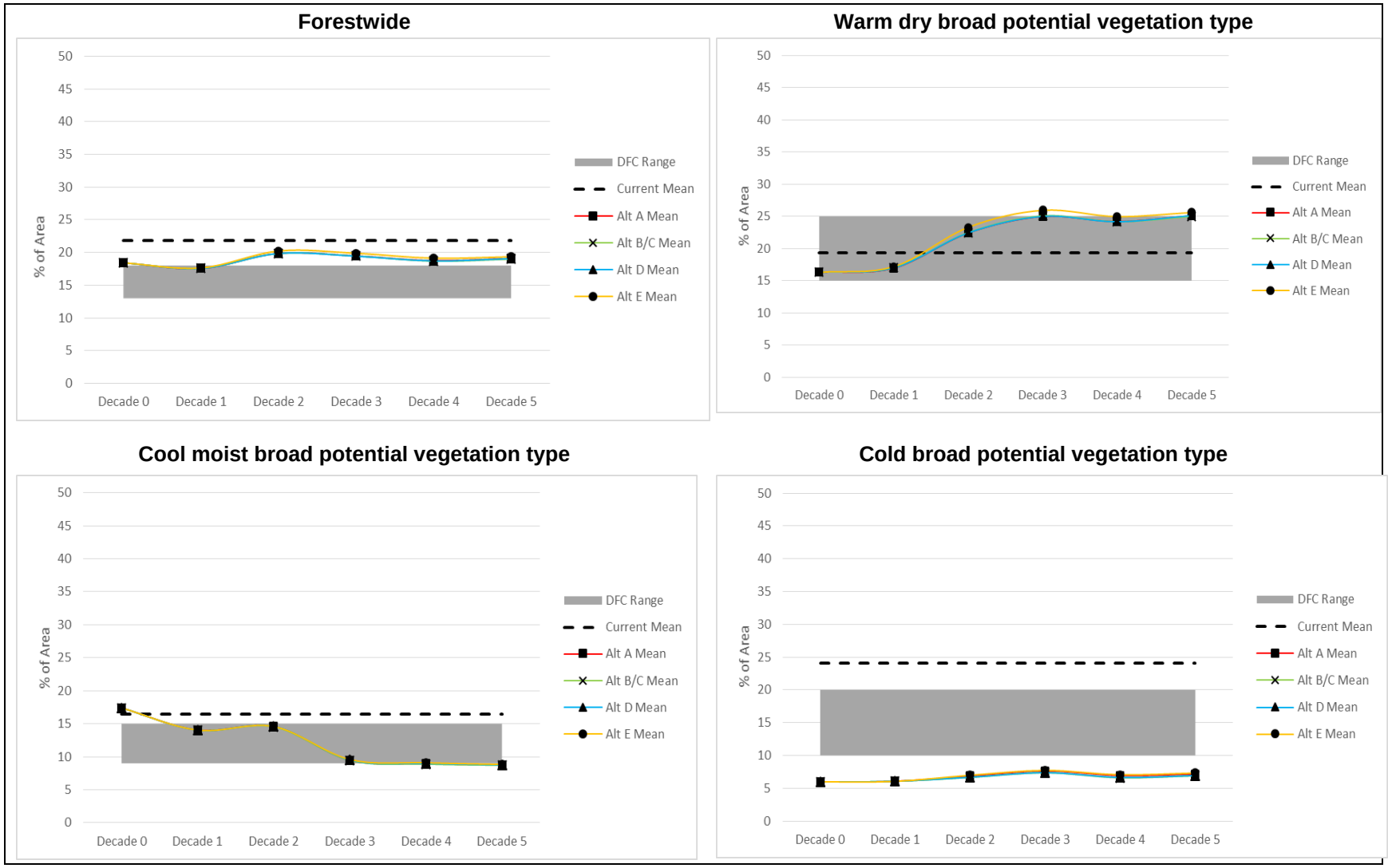


Figure 97. Low/Medium forest density class over 5 decades

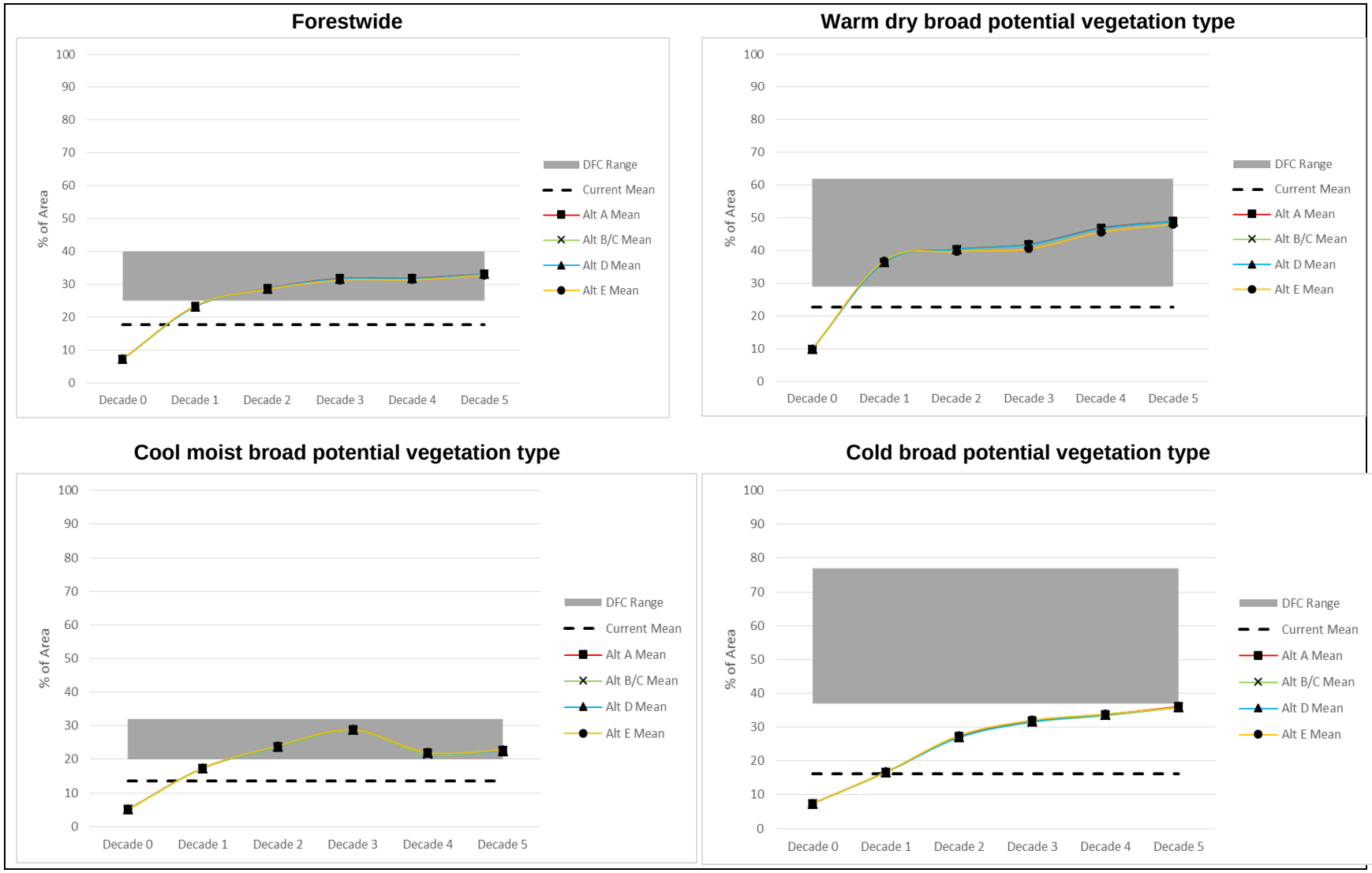


Figure 98. Medium/High forest density class over 5 decades

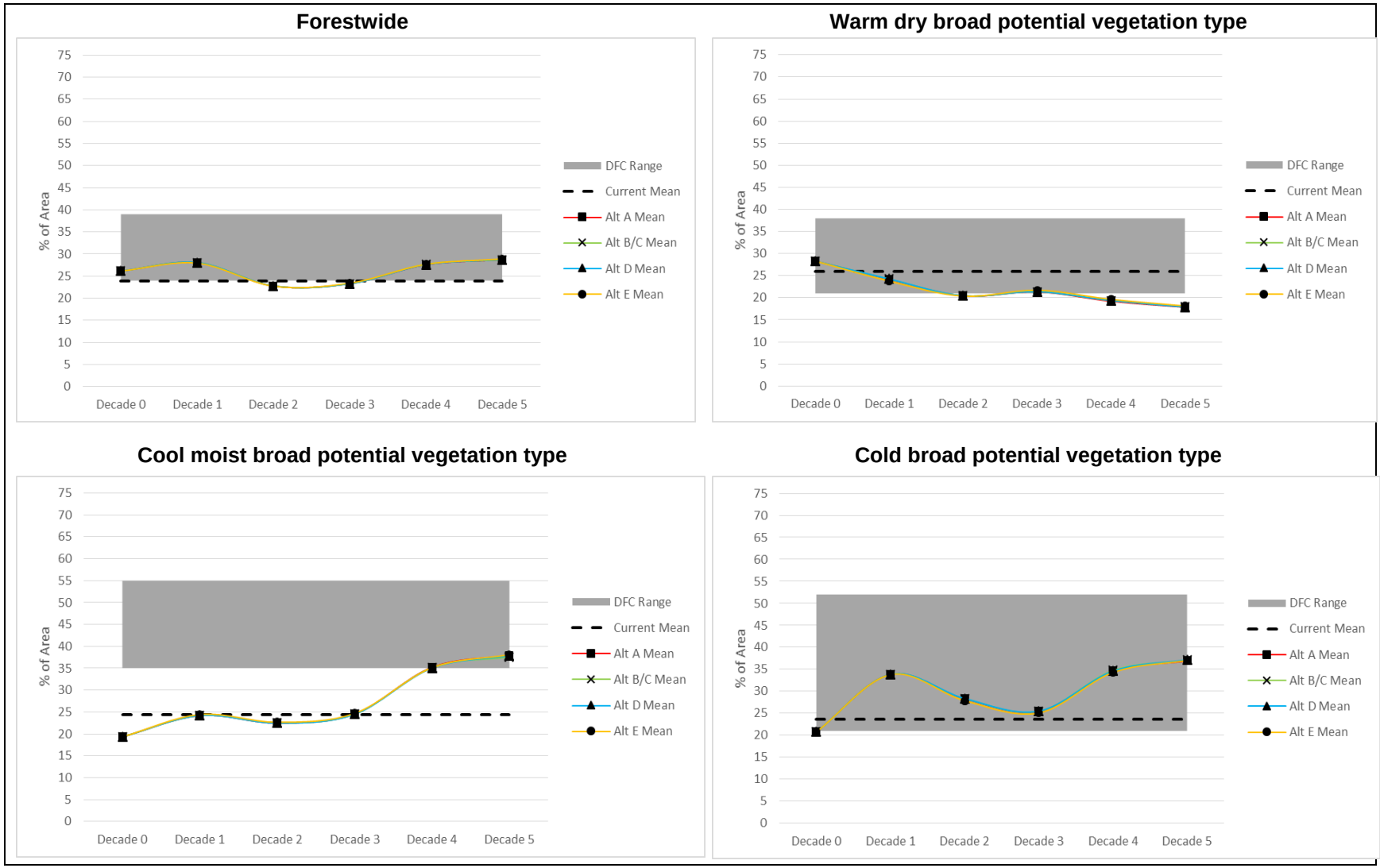
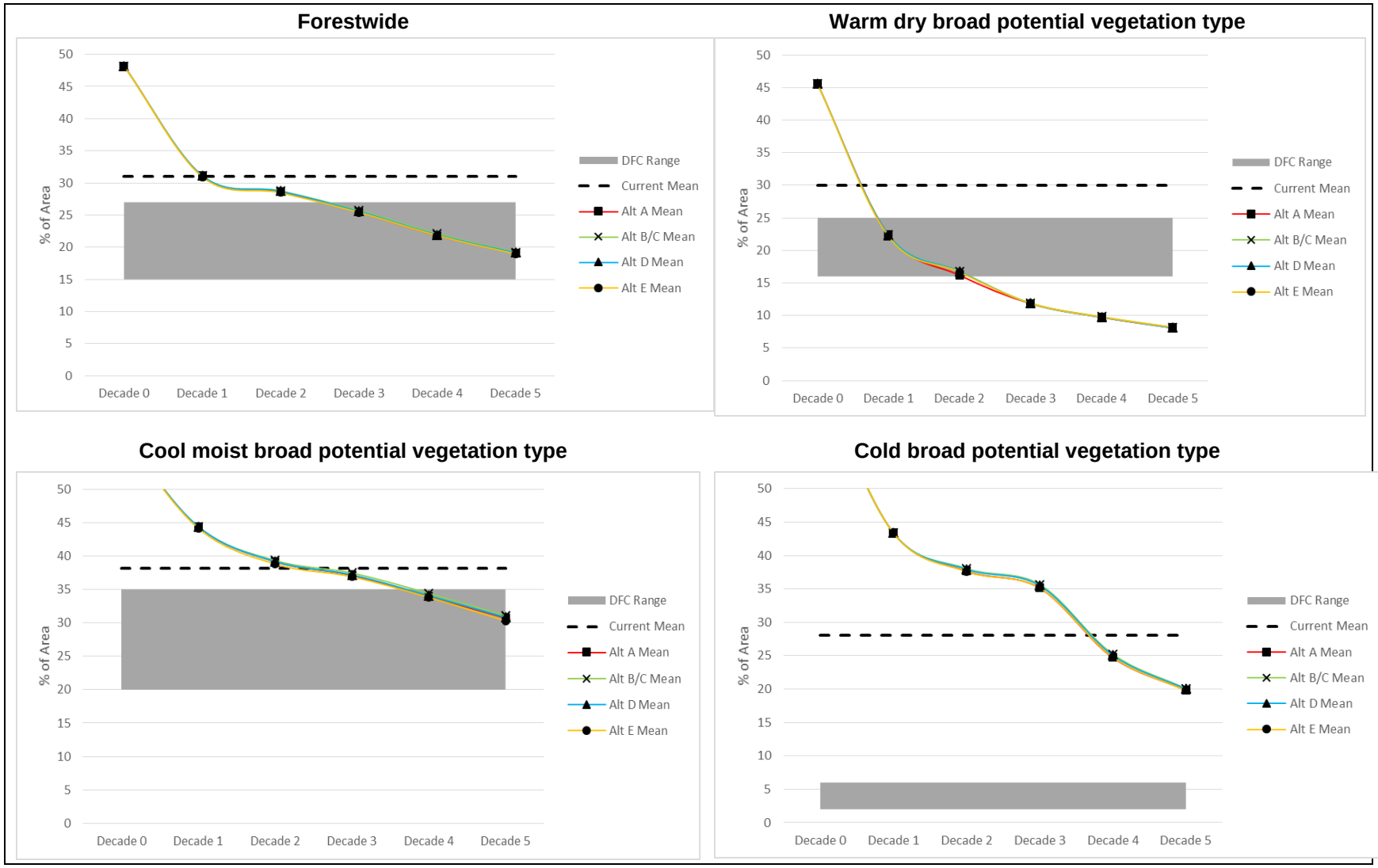


Figure 99. High forest density class over 5 decades



Forest Vertical Structure Class

No quantitative desired conditions are associated with forest vertical structure class because they are inherently provided by the natural ranges of composition and size classes; however they are included for analysis purposes to fully describe the suite of vegetation conditions on the landscape. Nonforested areas are not shown. Seedling/sapling forests from the NRV modeling are combined with the single-storied class, as young regenerating forests are predominantly in this condition. Areas without a forest vertical structure (nonforested or no data) are not shown; refer to the cover type and density class discussions to represent trends for nonforested vegetation.

Figure 100. Summary of vertical structure class, forestwide, average conditions at 50 years

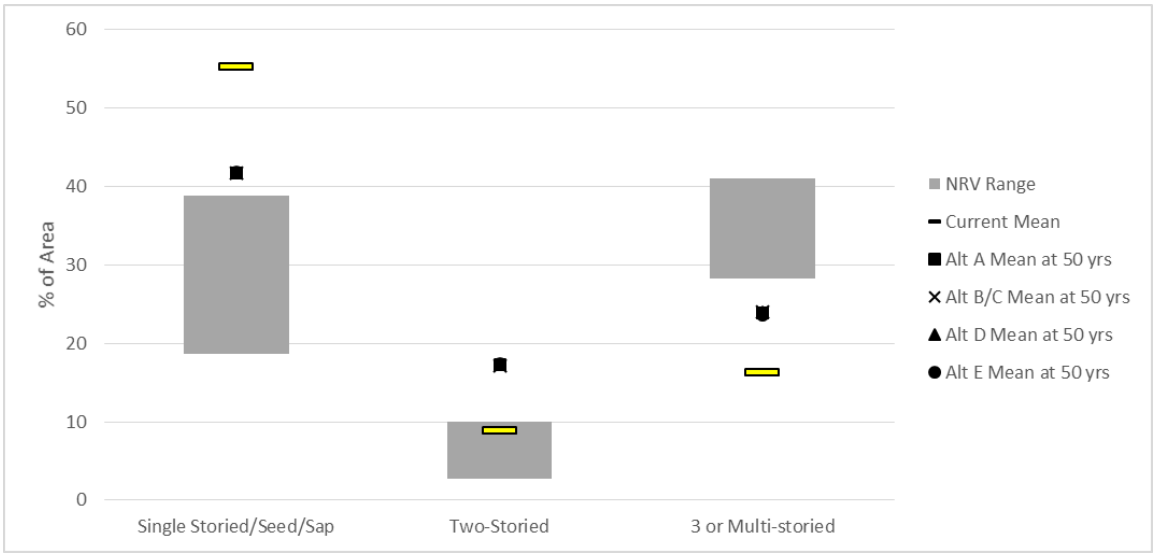


Figure 101. Single-storied vertical structure class over 5 decades

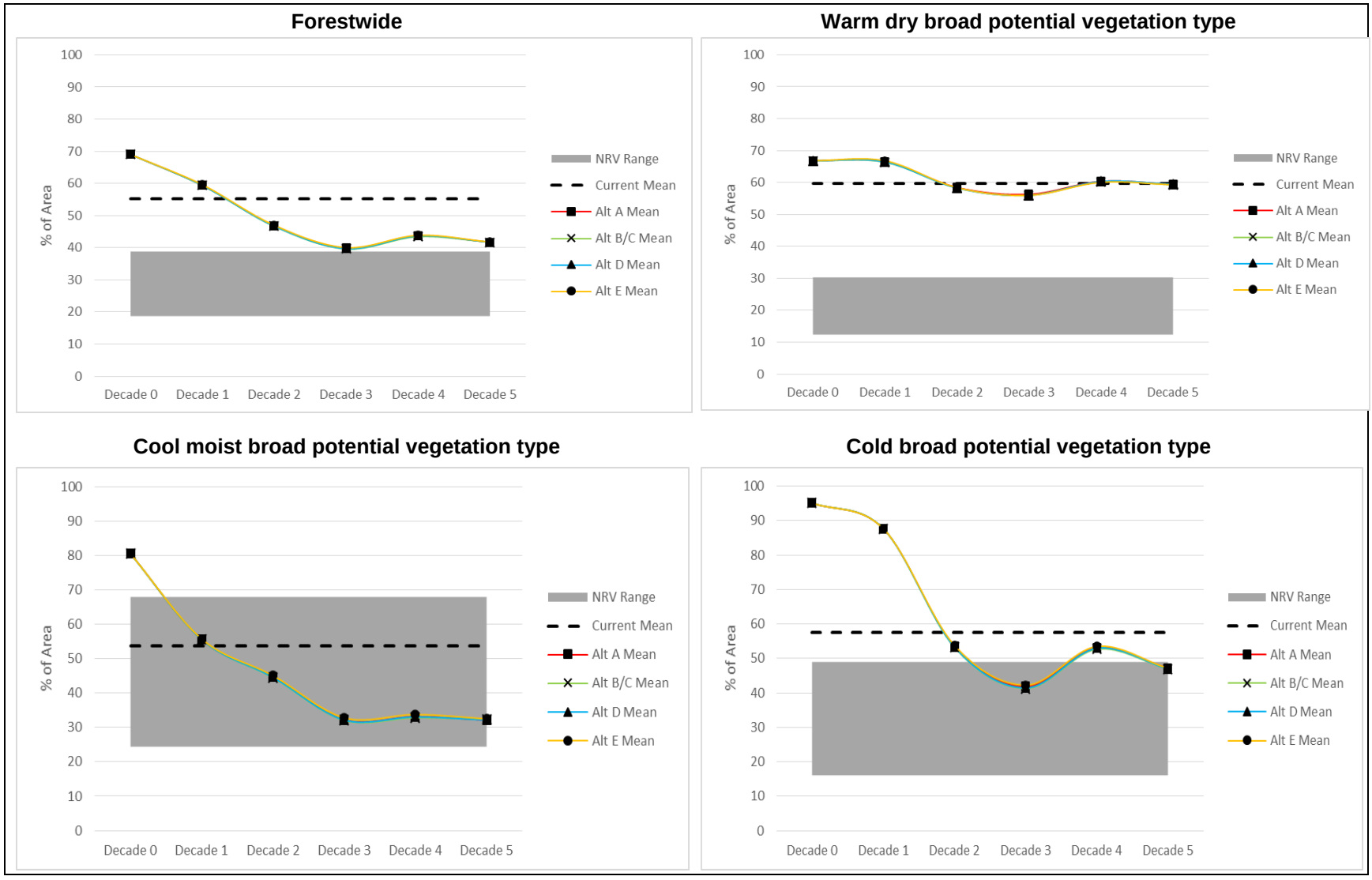


Figure 102. Two-storied vertical structure class over 5 decades

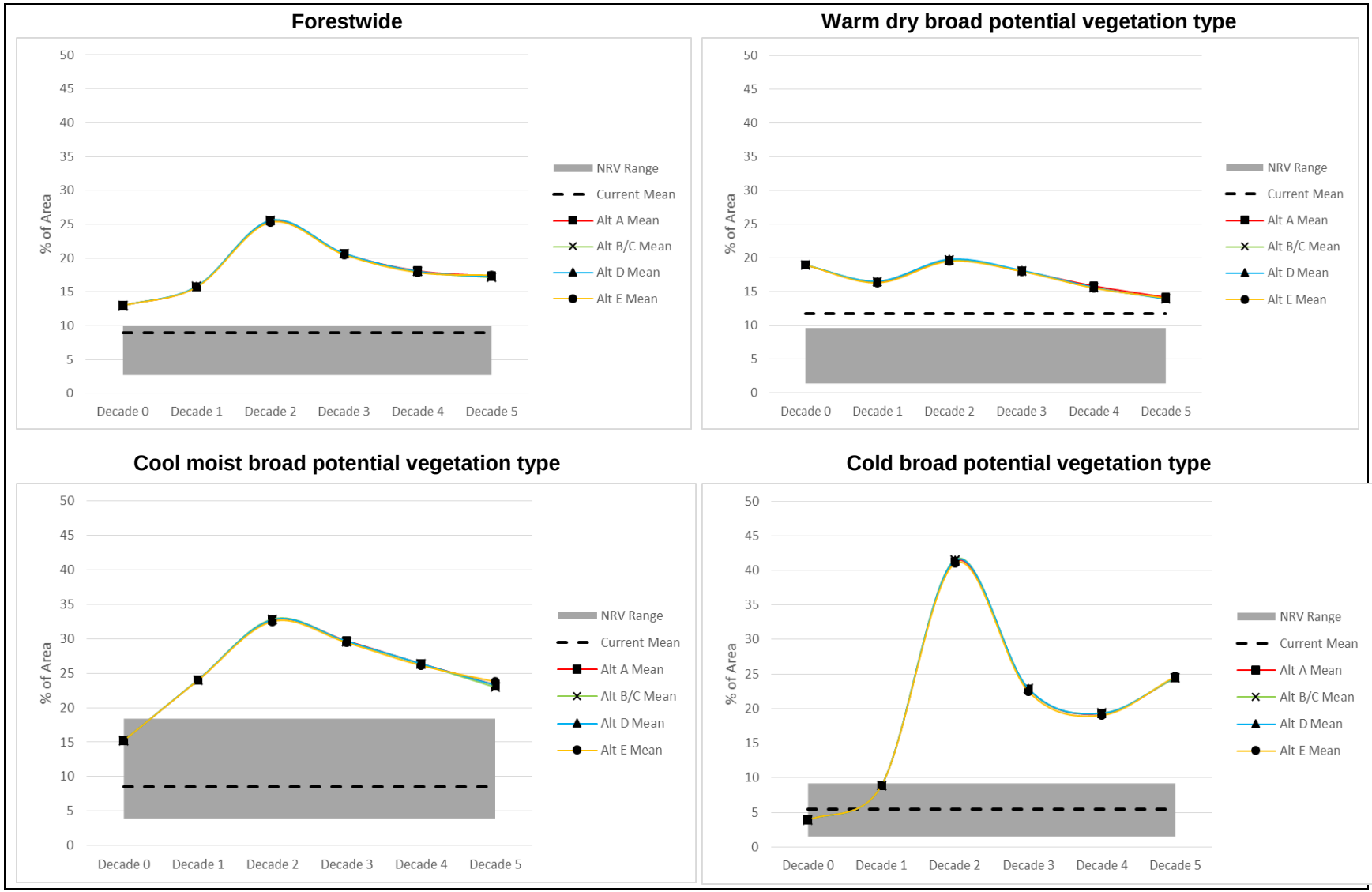
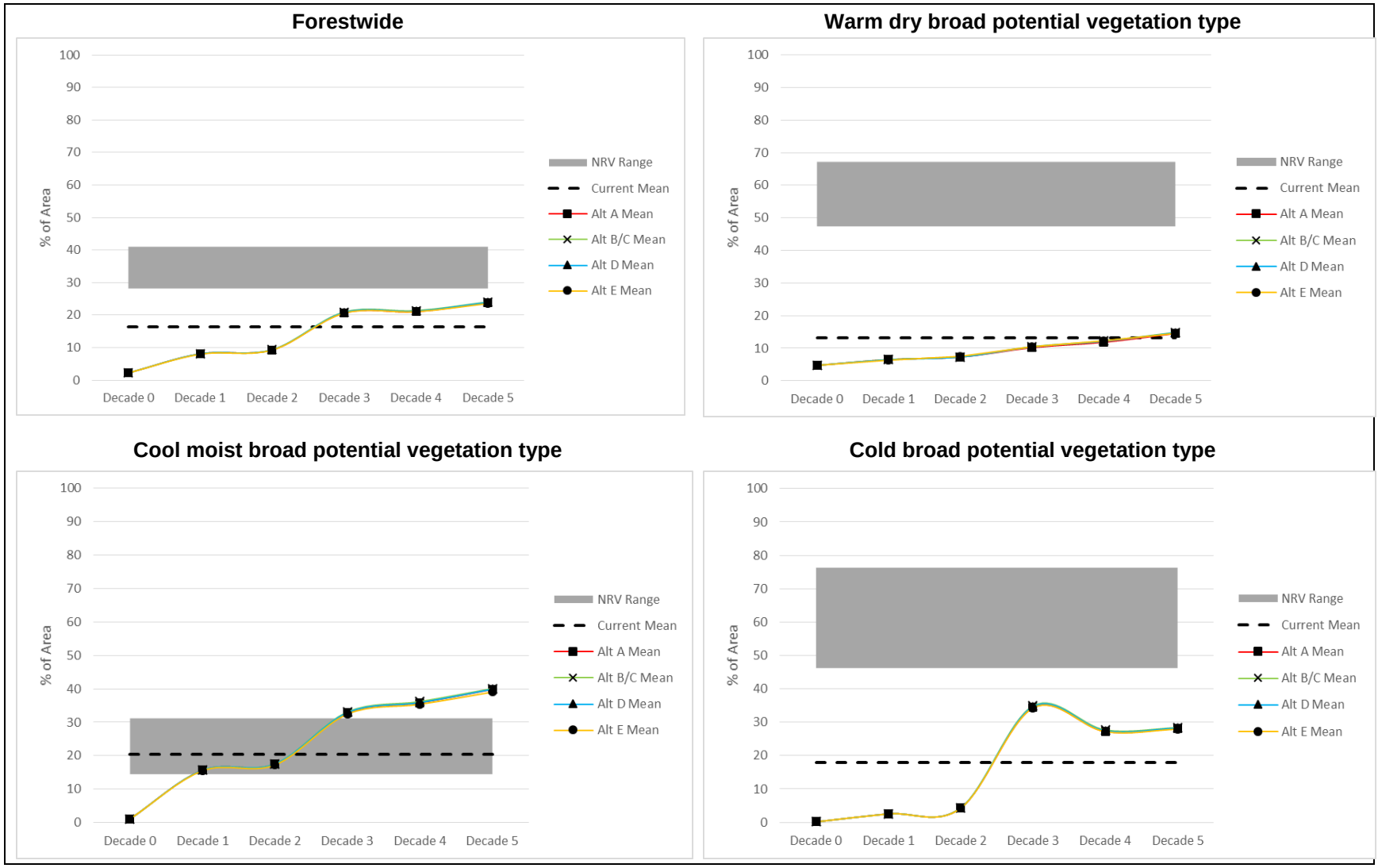


Figure 103. Three or multi-storied vertical structure class over 5 decades



Patch size of early successional forests

Early successional forests were defined as those in the seedling/sapling size class, as well as grass/shrub states found on forested potential vegetation types. The minimum patch size considered was 10 acres based on the pixel sizes of the data layer used for modeling. Two attributes of patch size were analyzed:

- *Average patch size*, which is a simple arithmetic mean; and
- *Area weighted mean patch size*, in which the mean is weighted based on the size of the patch. This metric reflects the largest average patches that would occur.

For the NRV modeling, the analysis was conducted in two ways. First, an opening was included in the calculation for as long as it remained in the seedling/sapling size class. This provides the ecological picture of the extent and duration of openings. This is the analysis that is pertinent to the effects discussed in the environmental consequences section. Second, the analysis was run assuming that a patch is no longer an opening beyond 10 years after its creation. This provides for assessing appropriate patch sizes for even-aged harvest entries as required by the National Forest Management Act. This information was used only for developing forest plan components and is not relevant to the effects analysis.

All alternatives displayed similar trends over time. The desired condition ranges match the NRV patch size analysis. Stratifying the landscape by broad PVT may artificially reduce the average patch sizes. For example, a large fire patch that crosses multiple PVTs may essentially create one large patch, but be calculated as several smaller patches based on the delineation of PVTs.

Table 7. Existing and NRV of early successional forest patch size[2] (acres)

Attribute	Forestwide	Warm Dry	Cool Moist	Cold
NRV Mean Patch Size of patches	81 (35-139)	29 (21-57)	95 (37-164)	33 (17-68)
NRV Area Weighted Mean Patch Size[1]	10,213 (223-72,288)	174 (47-4,210)	7,833 (195-45,694)	142 (24-868)
NRV Mean Patch Size of patches, limited to 1 decade duration[3]	117 (13-394)	32 (11-251)	128 (0-376)	24 (0-102)
Existing Condition Avg. Patch Size	113	49	76	39
Existing Condition Area Weighted Mean of patches	25,507	1,615	7,296	2,033

1 Weighted mean patch size provides an indication of the maximum or largest patch size

2 Patches had a minimum size threshold of 10 acres. Source for all data: SIMPPLLE modeling.

3 This analysis was used to inform the maximum opening size standard for Timber plan components.

Figure 104. Average patch size of early successional forests over 5 decades

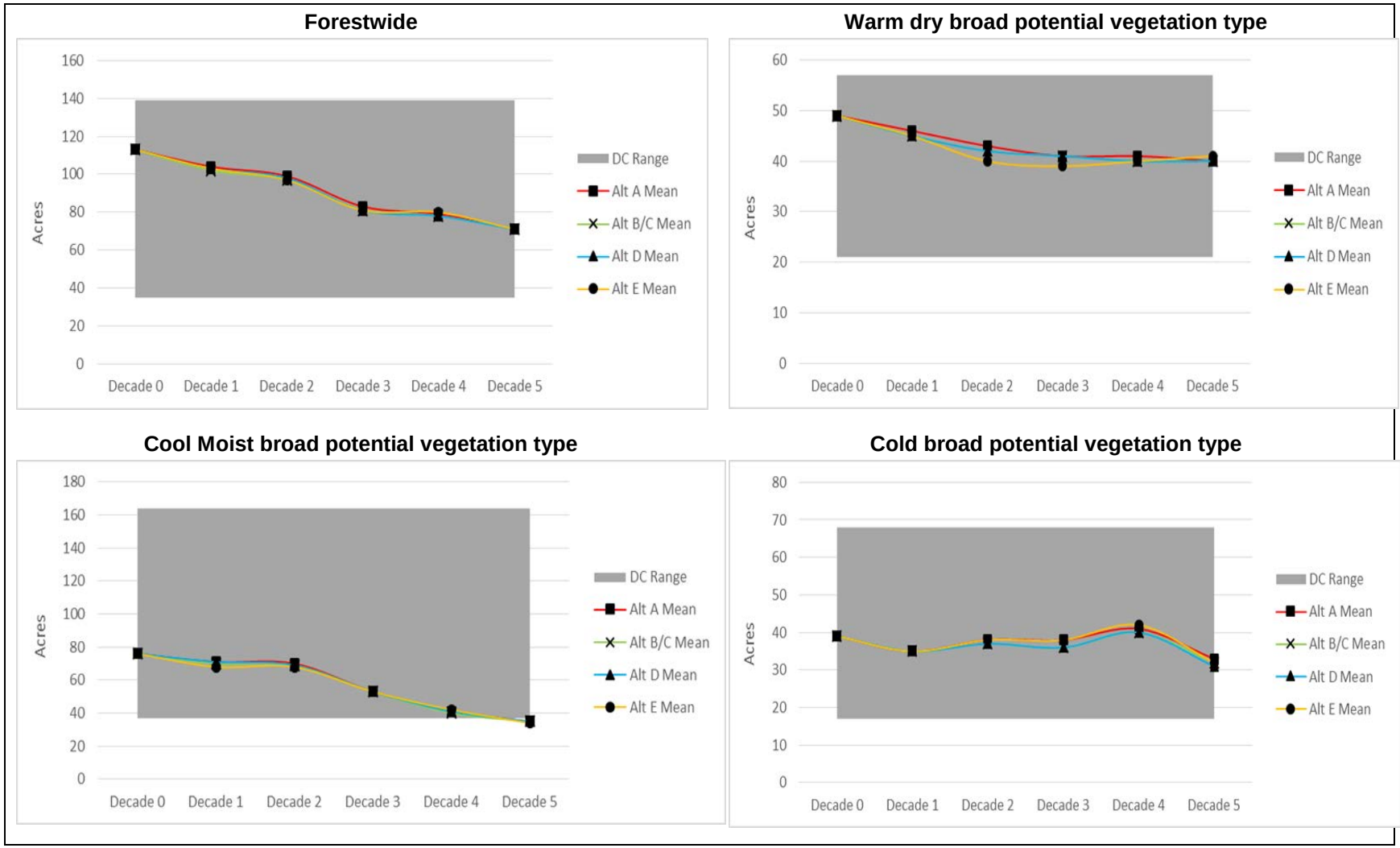
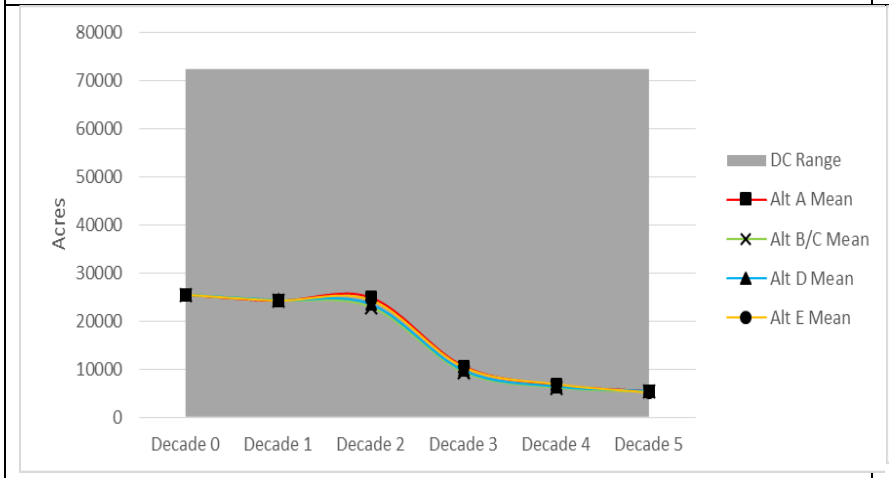
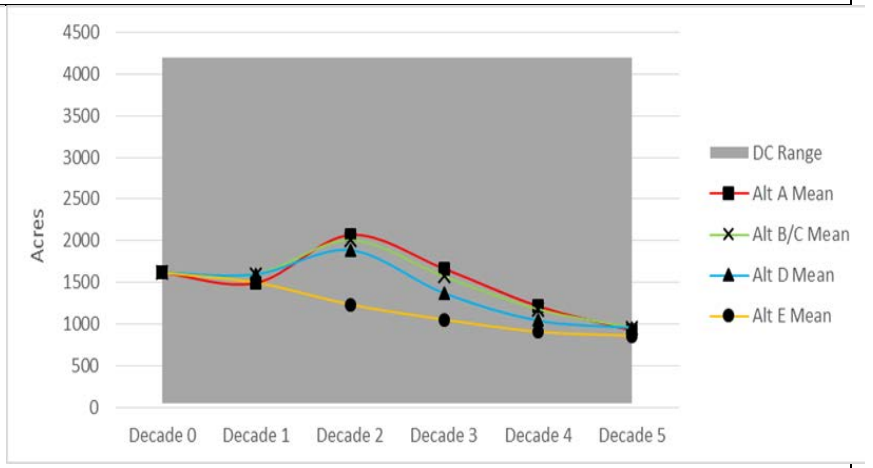


Figure 105. Area weighted mean patch size of early successional forests over 5 decades

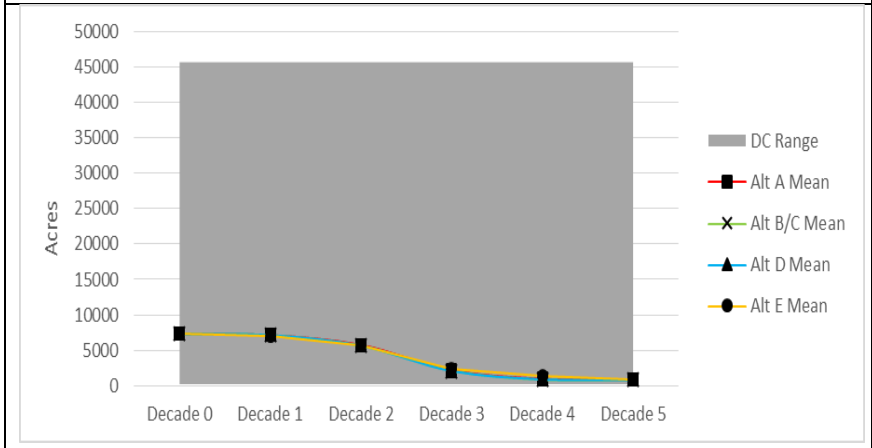
Forestwide



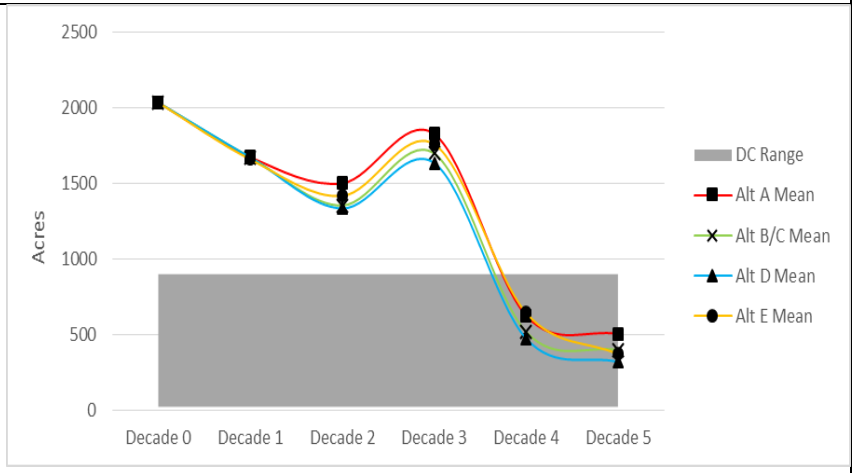
Warm dry broad potential vegetation type



Cool Moist broad potential vegetation type



Cold broad potential vegetation type



Old Growth

Three scales of analysis are used; all NFS lands are considered within these boundaries:

1. Forestwide - to provide information on the broad scale abundance of old growth.
2. Broad PVT - because old growth types and conditions vary by site capability.
3. Geographic area (GA) - because the unique disturbance and human use history of each area influences the abundance and type of old growth.

The desired condition for old growth in the revised forest plan (alternatives B, C, D, and E) applies forestwide and by each broad PVT, and indicates that old growth should be distributed across these areas. There is no data available to inform the appropriate scale at which old growth should be distributed. Small scales, such as individual watersheds or drainages, or even the smallest GAs, would not necessarily be appropriate to encompass the large disturbances that affect old growth or the array of natural vegetation conditions (such as nonforested plant communities) where old growth desired conditions would not be applicable.

FIA field procedures collect tree diameter and measure age so this data can be used to assess old growth, and thus provides a statistically sound estimate of the amount of old growth across the forest. Confidence intervals around estimates vary based on the size of the sample and the variability of vegetation. Two datasets are used to estimate old growth condition. The first, "Hybrid 2011", is used for forestwide and broad potential vegetation group estimates because it statistically represents all NFS lands across the plan area. The second, "F12_F15_Partial_IntGrid_4X_Hybrid_2016COMBINED", is used for estimates on all GAs except the Rocky Mountain Range, because these areas have had an intensified plot grid installed.

Old growth cannot be estimated into the future with the available models. However, several indicators that are available provide context to the old growth analysis. The large and very large size classes that are modeled with SIMPPLLE may have some correlation to old growth in that they represent large and very large tree concentrations as defined in appendix D of the Draft Plan. In addition, "old forests" were tracked with the Spectrum model, as shown in the Spectrum results subsection under the Timber section of this appendix; a subset of these areas may be old growth and therefore the trend may be similar.

Old growth desired conditions

Because old growth definitions are based in part on the presence of large trees, a partial correlation can be drawn with the presence of large and very large tree concentrations. The definitions of large/very large tree concentrations are consistent with minimum large tree criteria found in old growth definitions (Green et al., 1992). This concept is also similar to how large and very large size classes are modeled in SIMPPLLE. These areas are the most likely to contain sufficient large trees to be old growth.

The NRV analysis estimated a mean of about 40% (range 35 to 43%) of the landscape had large tree concentrations, and 11% (range 9 to 14%) had very large tree concentrations. Not all of these areas would actually have been old growth, because factors such as tree age and density are not reflected. To estimate a possible proportion, the current relationship between large and very large tree concentrations and old growth can be explored. About 44% of the FIA plots that currently have large/very large tree concentrations on the HLC NF plan area also classify as old growth. If this proportion were applied to the natural range of variation estimates for areas with large/very large tree concentrations, then it can be postulated that a natural range of old growth forestwide may have been 20-25%. This range would indicate that past amounts of old growth were likely higher than the existing condition. This conclusion is supported by the finding that the existing abundance of large and very large tree concentrations and size classes are lower than the NRV, especially in the warm dry broad PVT.

The use of exact values as desired conditions is unadvisable given the wide span of assumptions used. However, this evidence indicates qualitatively that old growth was likely more abundant in the past.

Old growth conditions vary depending on the site capabilities and on other factors unique to the site, such as disturbance history. Brief descriptions of desired composition and structure of old growth found on the HLC NF are shown in Table 8, based on the old growth types and criteria from Green et al (1992). The crosswalk between the habitat type groups used for old growth and the R1 broad PVTs is imperfect, but the most predominant relationship is shown.

Table 8. Desired old growth[1] stand conditions on the HLC NF

Old Growth Type	Habitat type group	Minimum age of large trees	Minimum number TPA/ DBH	Minimum basal area (ft^2/ac)	R1 Broad PVT[2]	Description
1 -DF	A	200	4 ≥ 17”	60	Warm Dry	Typically contain large diameter, old Douglas-fir and/or ponderosa pine; rare types have lodgepole or subalpine fir. A relatively open overstory canopy exists, but Douglas-fir can be dense in the mid and understory canopy layers with lack of disturbance. When this occurs, the large trees become more susceptible to bark beetle-caused mortality.
2 –DF	B, C	200	5 ≥ 19”	60		
4 –PP	A, B, C	180	4 ≥ 17”	40		
5 –PF	A, B	120	6 ≥ 9”	50		
6 -LP	A, B, C	150	12 ≥ 10”	50		
7 –SAF	C	160	12 ≥ 17”	80		
2 –DF	D, E, F, H	200	5 ≥ 19”	60	Cool Moist	Douglas-fir, Engelmann spruce, subalpine fir, and/or lodgepole pine are the dominant large, old trees; rare sites may have whitebark pine. Lodgepole pine may be single-storied, or support a developing understory of spruce and fir. Spruce and fir old growth is typically dense, with multi-canopy layers, with subalpine fir and spruce the most common mid and understory tree species
3 –DF	G	180	10 ≥ 17”	80		
6 -LP	D, E, F, G, H	150	12 ≥ 10”	50		
8 –SAF	D, E	160	7 ≥ 17”	80		
9 –SAF	F, G, H	160	10 ≥ 13”	60		
11 –WBP	D, E, F, G, H	150	11 ≥ 13”	60		
6 -LP	I	150	12 ≥ 10”	50	Cold	Engelmann spruce, subalpine fir, and whitebark pine are the most common large, old overstory trees. Because of the harsh conditions, tree growth is slower and old trees are smaller than in old growth at lower elevations. There are typically multi-canopy layers, though tree density may be low. Subalpine fir and spruce dominate the mid and lower canopy.
9 –SAF	I	160	10 ≥ 13”	60		
10 –SAF	J	135	8 ≥ 13”	40		
11 –WBP	I	150	11 ≥ 13”	60		
12 -WBP	J	135	7 ≥ 13”	40		

1 The old growth types, groups, and descriptions are based on the minimum criteria found in Green et al (1992).
2 This crosswalk shows the most dominant relationship between old growth habitat type group and R1 broad PVT; specific habitat types may vary.

SIMPPLLE model results for old growth

SIMPPLLE was used to estimate the abundance of large and very large forest size classes. These values are generally consistent with the classification of large and very large tree concentrations. The combined proportion of large and very large tree concentrations show correlation to areas that are most likely to be old growth. The figures below show the anticipated trend of large and very large size classes over time, forestwide, and by broad PVT as a proxy indicator for the potential expected trend of old growth.

Figure 106. Projected abundance of large and very large tree concentrations by alternative

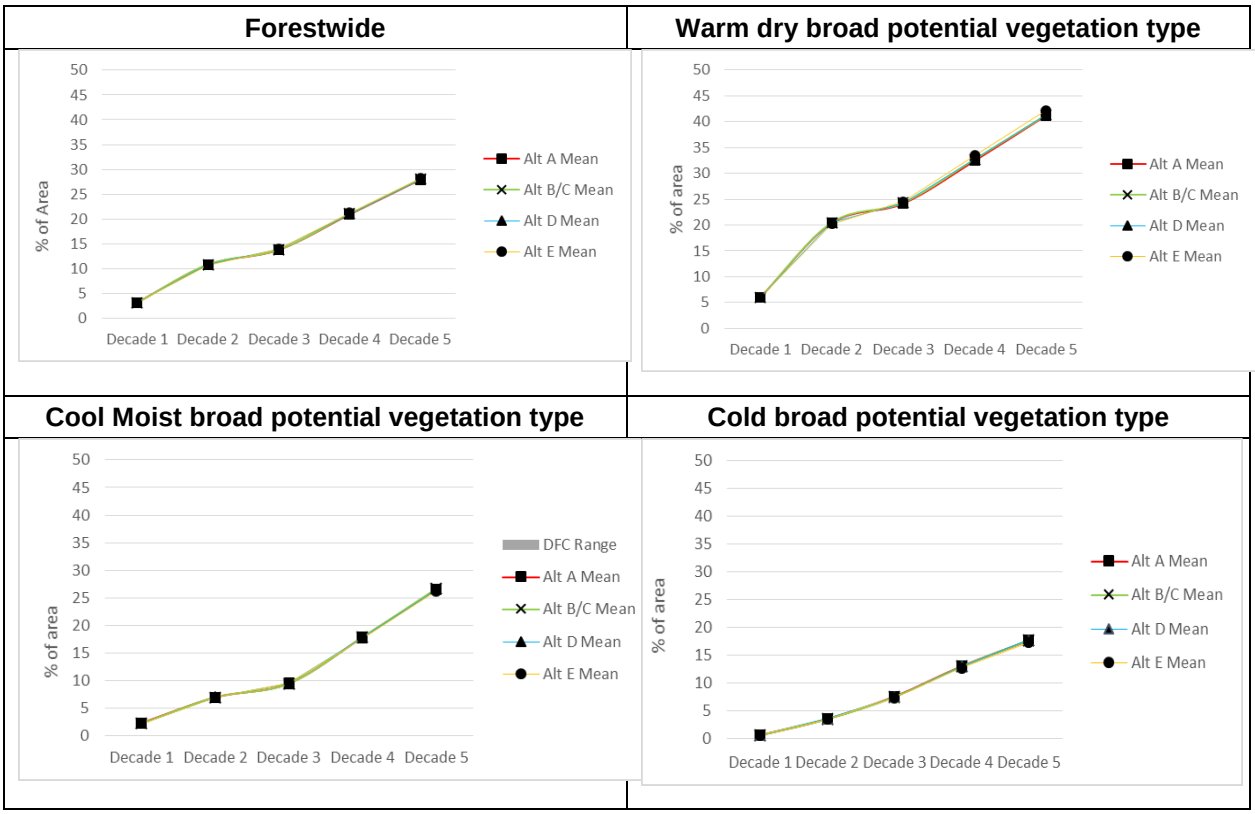
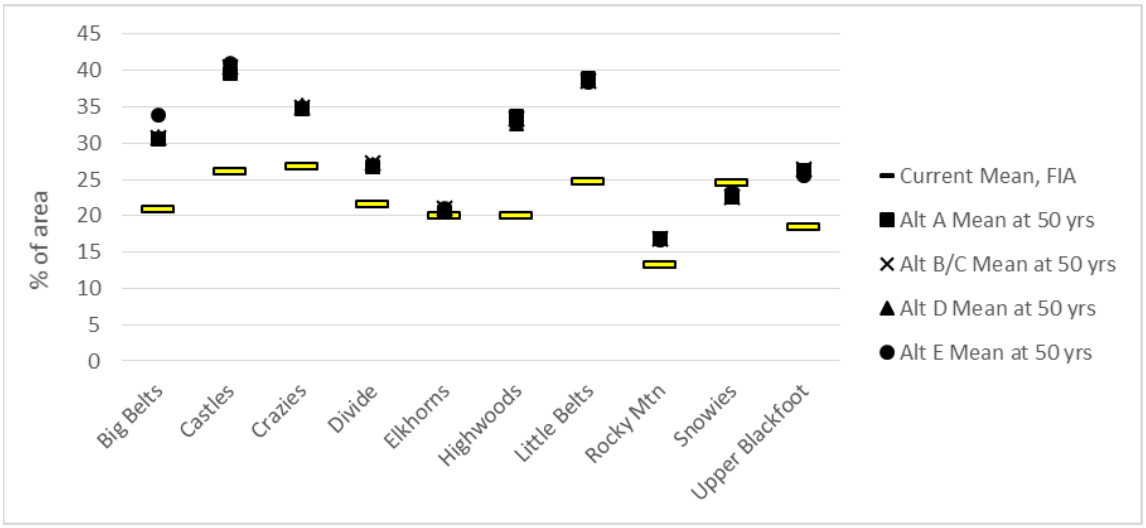


Figure 107. Projected abundance of large and very large tree concentrations by GA



Snags and Downed Wood

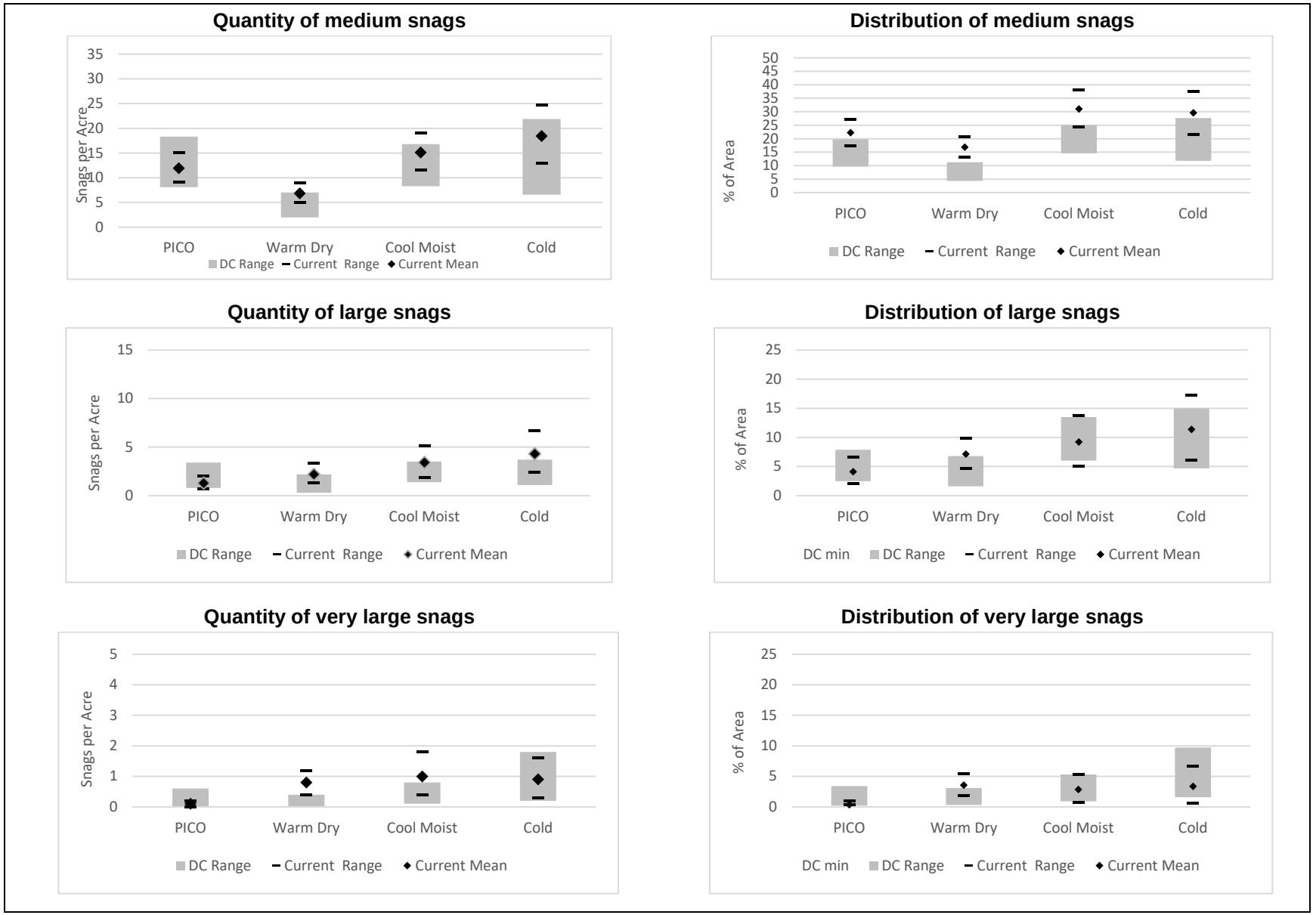
The analysis area for snags is Forestwide by snag analysis group. Snag analysis groups are consistent with R1 broad PVTs, except that areas dominated by lodgepole pine are addressed separately. This is important for the snag analysis because lodgepole pine is relatively short lived, generally smaller in diameter than other species, and subject to stand replacing disturbances which result in unique snag

conditions and dynamics. Downed woody debris is analyzed using broad potential vegetation groups to be consistent with the best available information to inform the desired condition.

Snag desired conditions

Desired conditions for snags (by snag analysis groups) are shown in the figure below, and are designed to reflect the conditions that would be expected to occur under natural disturbance regimes. The desired snags per acre are based on the 90% confidence interval around the mean of snags found in wilderness and roadless areas on the HLC NF, as measured by periodic FIA plots prior to the mountain beetle outbreak and reported by Bollenbacher and others (2008). The existing condition is based on the Hybrid 2011 FIA dataset. The desired distribution reflects the proportion of the snag analysis group that contains one or more snags in the indicated size class.

Figure 108. Forestwide existing and desired quantity of snags, by snag analysis group and size class



Coarse woody debris desired conditions

The desired condition for downed wood is to maintain amounts that contribute to forest structural diversity, soil ecological function, and habitat, focusing on coarse woody debris because larger downed wood is more valuable to ecosystem function than smaller debris. The desired conditions are based on the best available science (J. K. Brown, Reinhardt, & Kramer, 2003). The ecosystem conditions described in the paper are relevant but are based on data west of the continental divide and therefore adjustments using local data were appropriate.

Brown and others (2003) identified optimum ranges of coarse woody debris to provide biological benefits without creating an unacceptable fire hazard. The range that best meets resource needs is 5 to 20 tons per acre for the warm dry potential vegetation types and 10 to 30 tons per acre for other types. The amount and distribution of coarse woody debris in roadless and wilderness areas (as measured on FIA plots) was also used to inform the narrative of desired trends, because this reflects conditions on landscapes that have been influenced minimally by human activities. For the HLC NF the average amounts in these areas are slightly lower than the optimum described by Brown and others (2003) because the data for this type includes open savannas, where grass and shrubs dominate and trees are widespread. Therefore, the lower end of the range described by Brown and others (2003) is adjusted downward to account for the unique (drier) conditions found on the HLC NF.

Table 9. Existing condition and desired range of downed wood 3" diameter and greater

Broad PVT	Desired[1] tons/acre	Existing[2] tons/acre	Desired Trend and Distribution
Warm Dry	3-20	3.38 (2.66-4.19)	Coarse woody debris is variable in amount, size, species and stages of decay across space and time, emphasizing pieces 10" in diameter and 10' in length or greater, which are higher value for wildlife. Individual stands may have little or no coarse woody debris, or a higher amount. Very minimal or no coarse woody debris occurs in nonforested potential vegetation types. It may be appropriate for 30 to 50 percent of a forested potential vegetation type area to have little to no coarse woody debris at a given time. Amounts below the desired average are found on hot dry sites, in developed recreation areas, and where the concern for fire impacts to values at risk is elevated. Higher amounts may be found on moist sites and riparian areas, areas with low direct human influence, burned areas, and those with insect/disease infestations. Pulses of coarse woody debris occur following disturbances. Downed wood in pine-dominated forests may increase during the first decade of the Plan due a mountain pine beetle outbreak.
Cool Moist	10-30	7.22 (5.81-8.76)	
Cold	10-30	7.04 (5.33-8.91)	

1 The source of the desired tons/acre is Brown et al (2003), and FIA plot data measured in wilderness/roadless areas.

2 Data source for existing: R1 Summary Database, Hybrid 2011 FIA plots. The mean is displayed, with the bounds of the 90% confidence interval in parentheses.

Plants at Risk

The USFWS is responsible for determining species recognized under the ESA as threatened, endangered, and proposed or candidate. Once identified, the FS is responsible to manage for the ecological conditions that would contribute to the recovery of the listed species and conserve proposed and candidate species. Determining effects to federally-recognized species by alternative considers the degree of management activities or natural conditions that may pose potential stress or threat to the species.

The 2012 forest planning rule provides direction for determining which of species to be potential SCC, as described in the previous introduction section. The list of potential SCCs must meet the following mandatory requirement (FSH 1909.12 Section 12.52): The best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area. This information may be derived from the scientific literature, species studies, habitat studies, analyses of information obtained from a local area, and/or the result of expert opinion or panel consensus. Additional information is available in the assessment, the supplemental botany report in the project record, and the Region 1 Species of Conservation Concern Planning webpage: https://www.fs.usda.gov/detailfull/r1/landmanagement/planning/?cid=FSEPRD500402&width=full

Once SCC were defined, key ecosystem characteristics for species was evaluated and determinations made on whether forest-wide components maintained habitat quality needed by associated SCC by considering known locations of species and their habitats, as well as key drivers/stressors. Additional species-specific plan components were then considered and developed if needed. In other words, the extent and condition of each ecosystem or special type served as the habitat indicator for individual species, and for assemblages of at-risk species and overall floristic diversity. For most species, extent and condition of habitat typically constitute the best available scientific information indicating whether such populations would continue to persist with sufficient distribution in the planning area (2012 Rule Sec. 219.19), though known occurrences, trend data and known threats to species viability and used when available to compare each alternative.

Determinations for each species consisted of a viability evaluation, which examined whether plan components provide ecological conditions necessary to maintain a viable population of each species of conservation concern in the plan area. The viability evaluation was conducted using both a coarse filter and a fine filter approach, again using known populations, habitat extent and condition, and known threats as indicators. For the coarse filter approach, species were grouped by habitat guilds. This coarse filter approach assumes that viability of SCC is broadly dependent upon the integrity of the coarse ecosystems where they currently occur. We made qualitative, rather than quantitative, evaluations to compare the action alternatives to the no-action alternative forest-wide plan components. The coarse filter approach was used to compare forest-wide plan components of the old forest plans (Alternative A) and the new plan (Alternatives B-E) using habitat guilds and considering species in a broader context. However, the habitat guilds outlined below are roughly, but not exactly aligned with floristic geographic subdivisions, to which at-risk plant populations are often associated. Since the integrity of whole ecosystems does not necessarily ensure persistence of all species of conservation concern, particularly those with very limited distribution, we conducted additional fine filter analyses (by quantitative species-specific population and habitat indicators) to ensure that persistence is provided for all plant SCC to compare each alternative.

The fine filter viability evaluation focuses on species-specific data rather than habitat guilds and was conducted to compare the analysis of (1) percentage of known occurrences within different management areas, such as designated wilderness, recommended wilderness or lands suitable for timber production, (2) estimated percentage of available potential habitat for each species in those management areas, and (3) known threats to each individual species of conservation concern. Each alternative was considered using the fine filter approach. The habitat guilds are not used to quantitatively compare alternatives. For whitebark pine, an at-risk plant species that is also a candidate species for federal listing, an additional indicator, population trend, was also evaluated. For this species, where trend information related to management activities has been documented in the plan area, quantitative, species-specific information was available for analysis. The adjustment of indicators was selected between the coarse and fine filter analysis because relative differences among alternatives could be readily compared. An overview of all at-risk species known in the plan area and species' respective determination rationale are presented in the Botany supplemental report in greater detail.

Invasive Plants

Effects to invasive species is indicated by evaluating the difference in frequency, intensity, or type of management activity or natural processes by alternative, insofar as they may potentially disturb the ground and result in greater risk of weed spread or invasion. The process for identifying risk and impacts resulting from invasive species is completed by FS botanists and vegetation specialists.

The geographic scope of the analysis for non-native invasive plants are the national forest system lands of the HLC NF. This area represents the lands where changes may occur to vegetation as a result of management activities or natural events. For cumulative effects, the analysis area also includes the non-national forest system lands within and adjacent to the administrative boundary of the HLC NF.

Two temporal scales were chosen to assess the current condition of invasive plants:

- Inventory data collected over the past 14 years (beginning in 2001) has been summarized to characterize current invasive plant infestations (in acres) on the HLC NF.
- Treatment data collected during the past 5 year period (2010-2014) has been summarized to characterize invasive plant treatments (in acres) across the HLC NF. This allows for the use of the most recent and relevant data in regards to invasive plant treatments.

The following methods and associated data were used to analyze the current condition of invasive species:

- Summarization of existing Geospatial Information Systems data as entered through the Threatened, Endangered, and Sensitive Plants, and Invasive Species database and reported through the Geospatial Interface;
- Summarization of existing Forest Service Activity Tracking System data;
- Literature review of the best available science.

Terrestrial Wildlife Diversity

In developing plan components and in analyzing their potential effects on the diversity of native wildlife communities, we sought information on local wildlife populations and habitat factors from sources described above in the section on best available scientific information. We identified key ecosystem characteristics, including those that support native wildlife species, assessed system drivers and stressors, and estimated the natural range of variation for key ecosystem components. All of these are documented in the Assessment (U.S. Department of Agriculture, Forest Service, Northern Region, 2015). During the planning process, evaluations were made regarding whether wildlife species' needs would be met by plan components that were being developed to maintain or restore ecosystem diversity and integrity.

This report relies on vegetation models (SIMPPLLE and Spectrum) to estimate and predict the current status, NRV, and predicted future condition of key ecosystem characteristics that comprise wildlife habitats. The Terrestrial Vegetation and Timber sections provide information regarding the methods, accuracy, and limits of those models and their products. Estimates and predictions made for key ecosystem characteristics were evaluated using the best available scientific information regarding the habitat needs of native wildlife species, in order to assess the effectiveness of plan components in maintaining wildlife diversity.

For most habitats and species considered in this report, the analysis area is NFS lands within the administrative boundary of the HLC NF. The cumulative effects analysis area considers management of adjoining lands. The anticipated life of the forest plan is about 15 years. Management actions that occur under direction of the plan have the potential to impact wildlife species and their habitats for many decades, however, the analysis of potential vegetation and therefore habitat change spanned the next 50 years (refer to Terrestrial Vegetation section).

At-Risk Terrestrial Wildlife Species

The 2012 Planning rule states that plan components that provide for ecological conditions for ecosystem integrity and ecosystem diversity are the primary context for the evaluation of at-risk species. For most species, the only practical quantitative evaluation of their required ecological conditions is an assessment of habitat conditions (ecological conditions). Therefore, this report relies on the analysis completed in the Terrestrial Vegetation section, and other sections as appropriate, regarding the ecological conditions required by at-risk species. As such, the methodologies and science used in the analysis of terrestrial vegetation is inherent in the discussion and conclusions provided in this section.

This section also relies primarily on information in the scientific literature, and in published and unpublished reports regarding the presence, distribution, and requirements of at-risk wildlife species and potential impacts on them of existing and proposed management actions. Research reports and literature are frequently not available specifically for the HLC NF or nearby areas, or for the specific management proposed in the draft plan and alternatives to the draft plan. Therefore in this section we have made inferences in applying information and conclusions from reports and literature to species, habitats, and management actions on the HLC NF have been made.

The methods used for selecting species of conservation concern for the HLC NF are documented on the Region 1 Species of Conservation Concern web page (https://www.fs.usda.gov/detailfull/r1/landmanagement/planning/?cid=FSEPRD500402&width=full). That process included extensive coordination with the HLC NF, and review of available data, observations, scientific literature, published and unpublished reports, and other information as documented there.

Habitat models used to estimate current and future habitat for some at-risk species discussed in this report are the same as those used to estimate current and future amount and distribution of terrestrial vegetation. Methods for modelling vegetation, as well as information about accuracy of those models, are described in the Terrestrial Vegetation section, and in supporting materials in the project file. Estimates of wildlife habitat were made using specific queries from those vegetation models, and therefore assume the accuracy of the model that was queried. Information regarding the queries used to estimate wildlife habitats is available in the project file. Models are based on accumulations of assumptions and therefore vary in their ability to predict actual habitat, and they cannot predict whether animals will actually use habitat as depicted.

SIMPPLLE model results for at-risk wildlife species

Flammulated owl

Flammulated owl nesting habitat is represented by the proportion of land in select warm dry habitat types dominated by ponderosa pine forest, with 1-2 canopy layers, 15-60% canopy cover, and greater than or equal to 15” average diameter. The following figures display forestwide results; GA-specific results are available in the planning record.

Figure 109. Flammulated owl nesting habitat, average acres/decade for 50 years compared to NRV by alternative

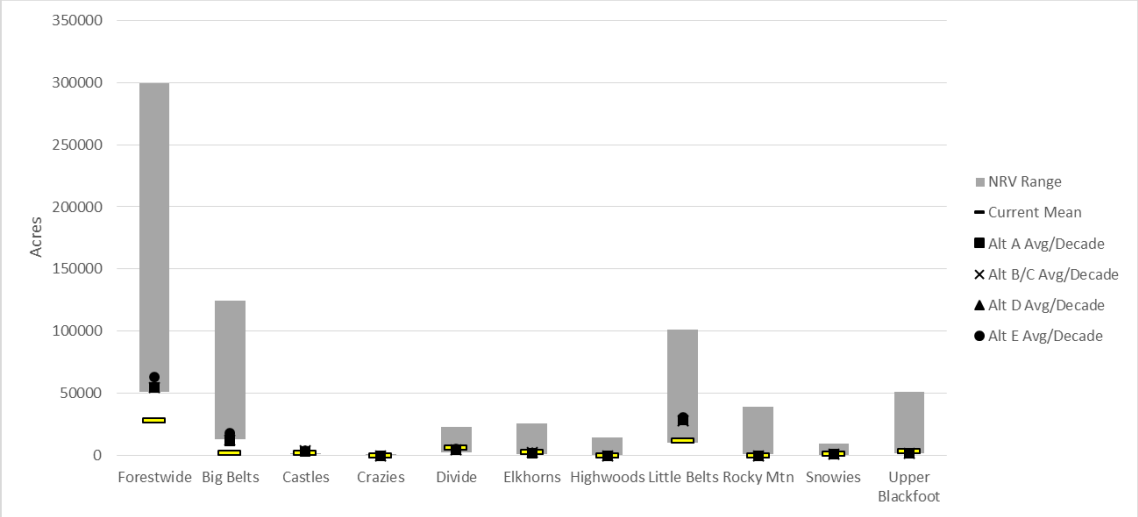
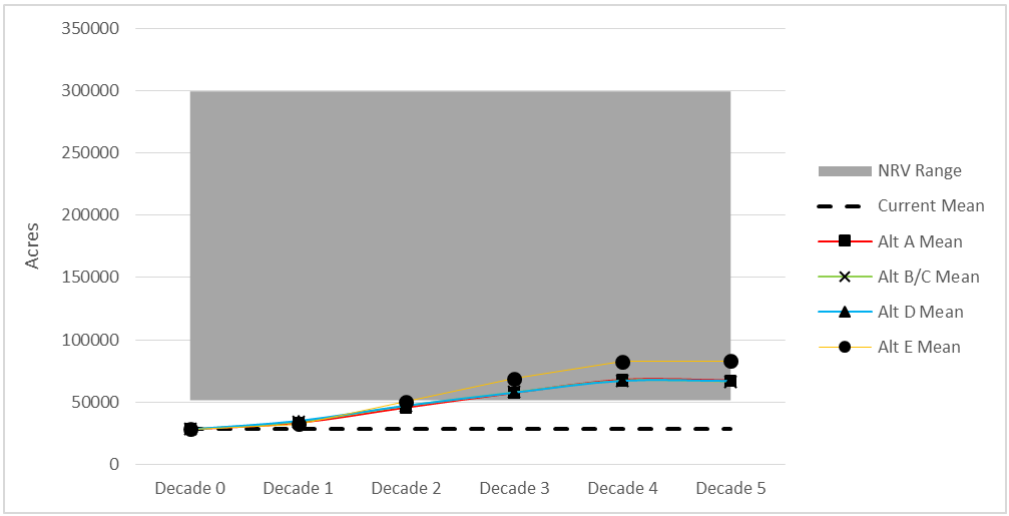


Figure 110. Flammulated owl nesting habitat over time by alternative Forestwide by alternative



Lewis's woodpecker

Lewis' woodpecker nesting habitat is represented by the proportion of land on select warm dry habitat types dominated by Douglas-fir, ponderosa pine, aspen, or western larch, with 15-40% canopy cover and greater than or equal to 15" in diameter. The following figures display forestwide results; GA-specific results are available in the planning record.

Figure 111. Lewis's woodpecker nesting habitat average acres/decade over 50 years compared to NRV by alternative

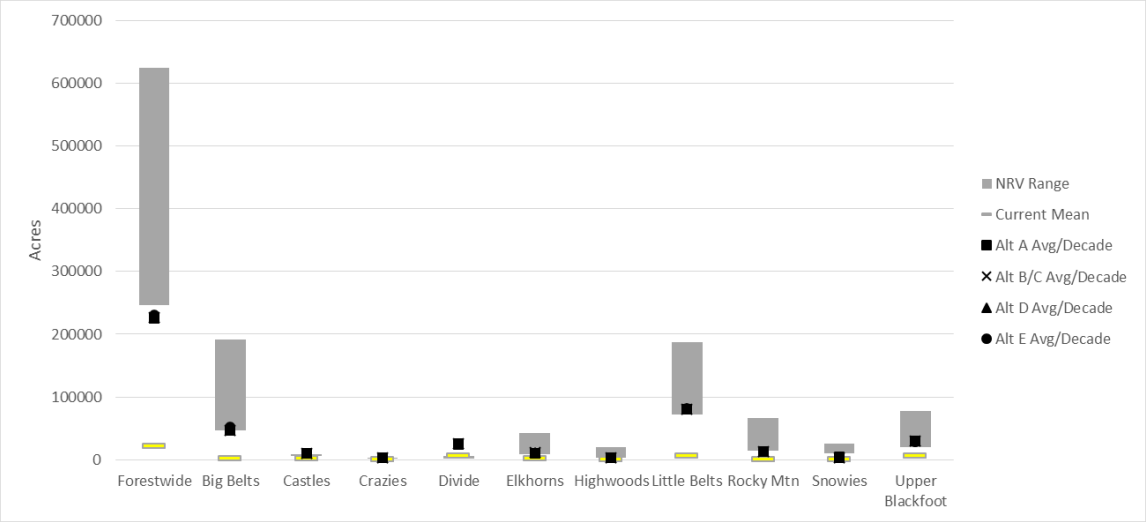
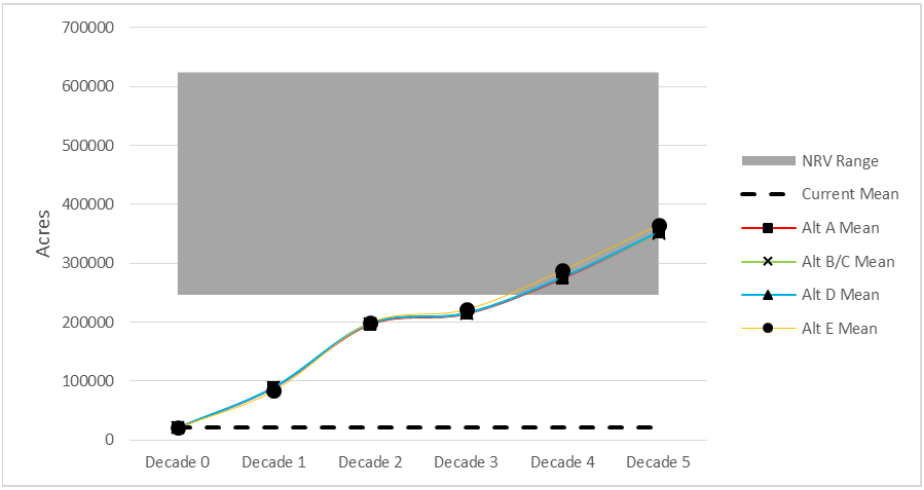


Figure 112. Lewis's woodpecker nesting habitat forestwide over time by alternative



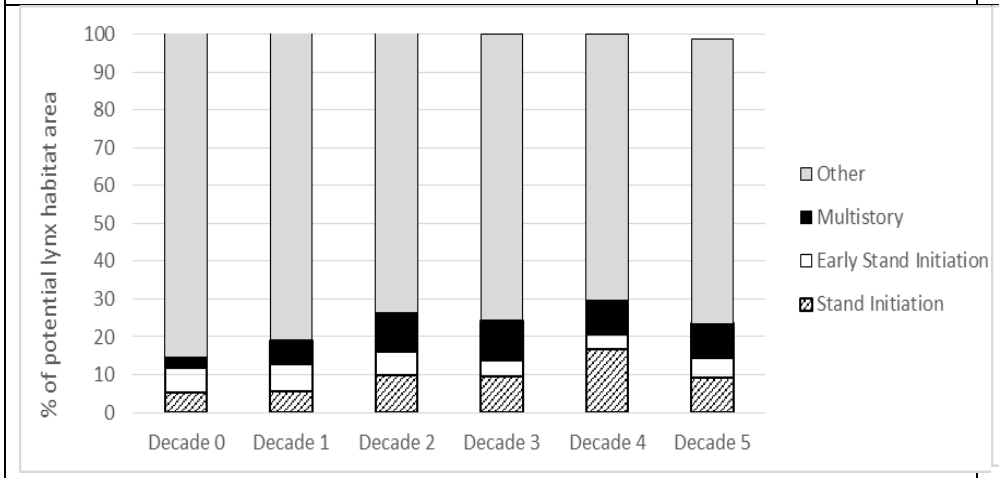
Canada lynx

A variety of Canada lynx habitat conditions were modeled within *potential lynx habitat*, which is represented by subalpine fir, Engelmann spruce, or select moist Douglas-fir habitat types within 300' of the other types, above 5000' elevation. Several summary charts are included in the body of the DEIS. The charts below show results for each habitat condition and GA here to supplement the analysis.

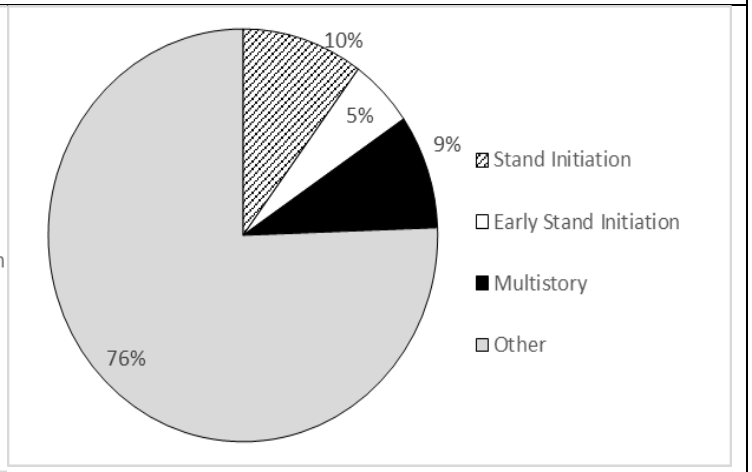
- Stand initiation hare habitat: potential habitat with greater than or equal to 40% forest canopy cover in a seedling, sapling, or pole size class or 15-40 years post-stand replacing fire or even-aged regeneration harvest.
- Early stand initiation hare habitat: potential habitat with less than 40% forest canopy cover in a seedling, sapling, or pole size class or 15-40 years post-stand replacing fire or even-aged regeneration harvest.
- Mature multi-story habitat: potential habitat with more than 2 canopy layers, greater than or equal to 40% forest canopy cover, and greater than or equal to 10" average diameter in size.
- Other: potential habitat that does not meet one of the other habitat criteria.

Figure 113. Canada lynx habitat over time, average of all alternatives, by habitat category – Big Belts and Castles GAs

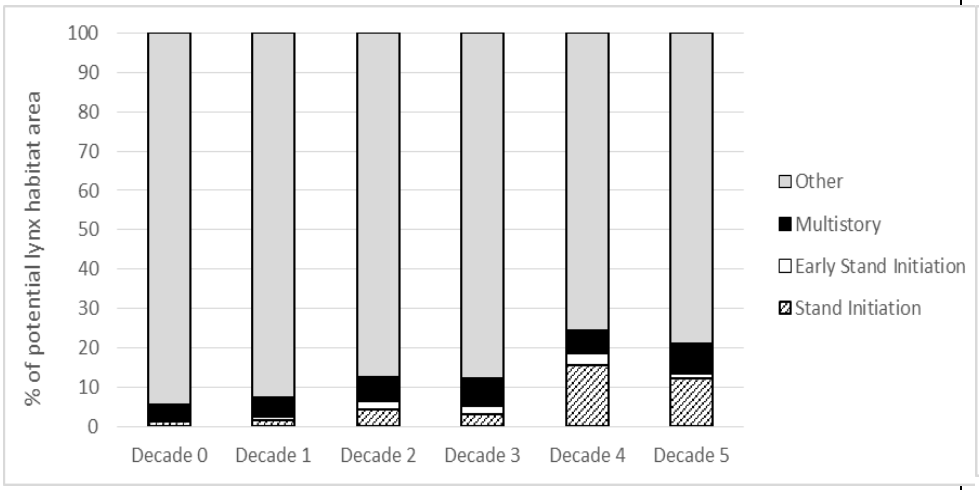
Big Belts – habitat over time



Big Belts – average of 5 decades



Castles – habitat over time



Castles – average of 5 decades

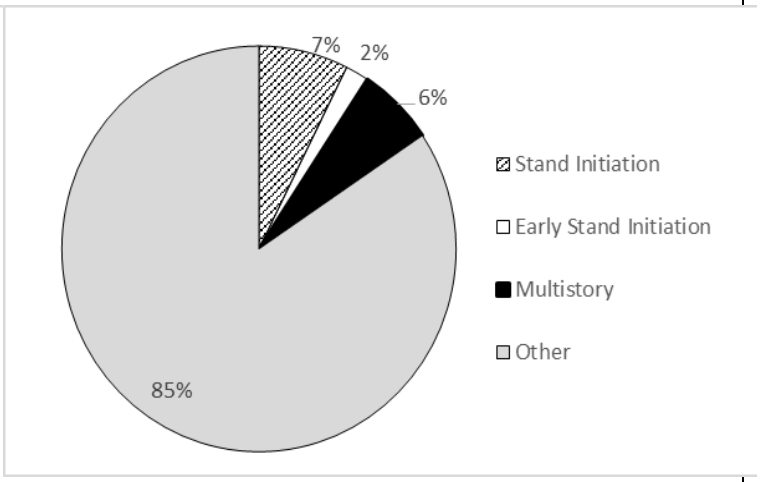
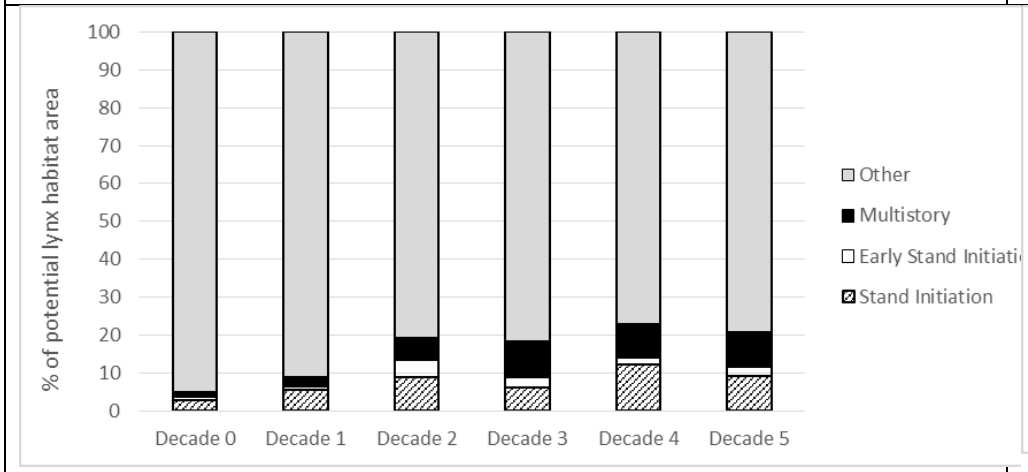
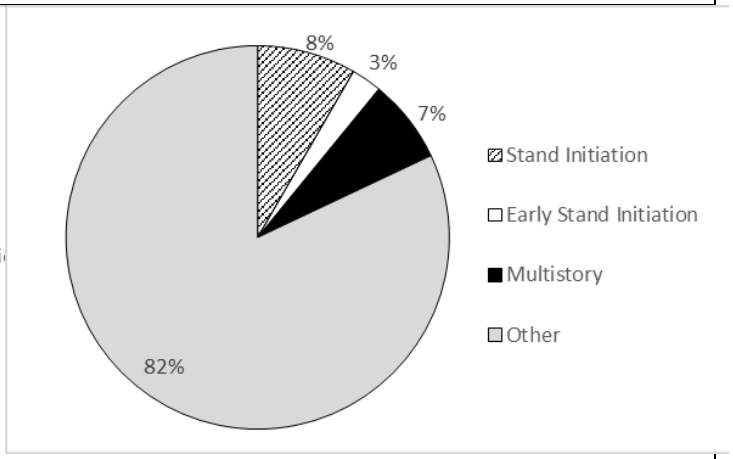


Figure 114. Canada lynx habitat over time, average of all alternatives, by habitat category – Crazies and Divide GAs

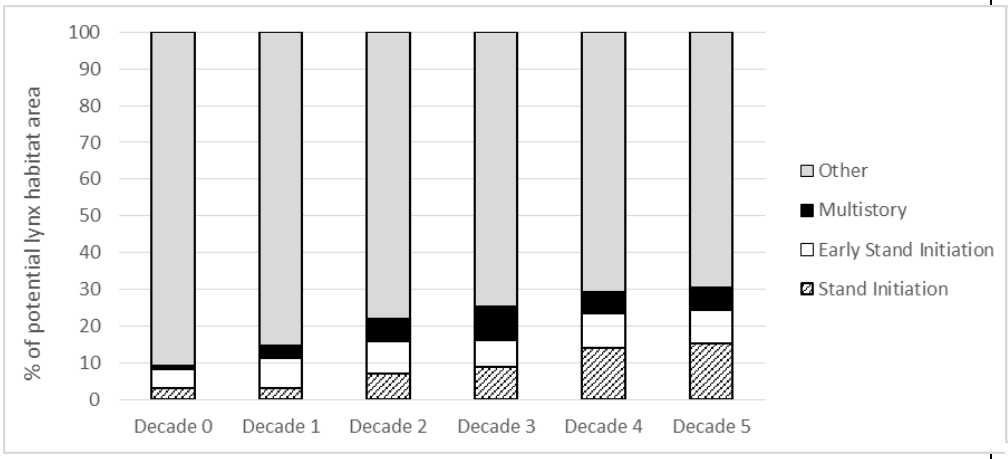
Crazies – habitat over time



Crazies – average of 5 decades



Divide – habitat over time



Divide – average of 5 decades

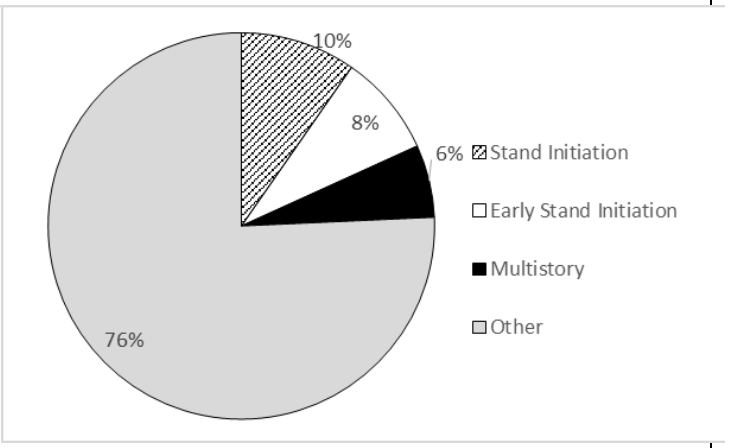
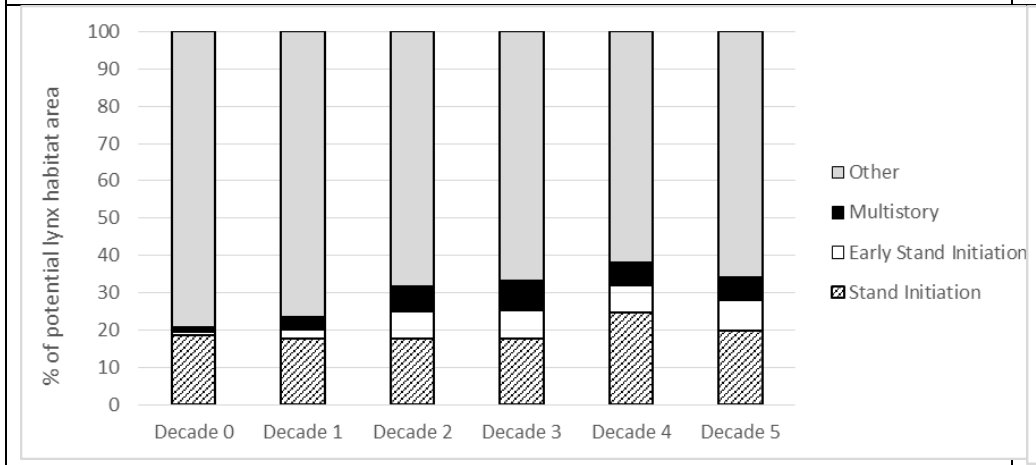
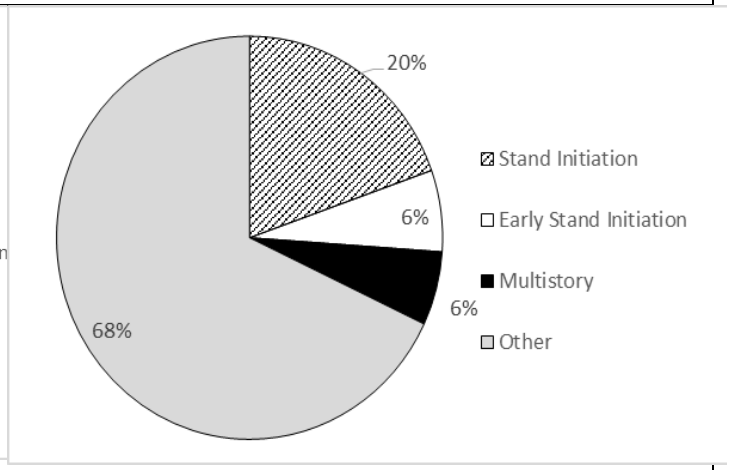
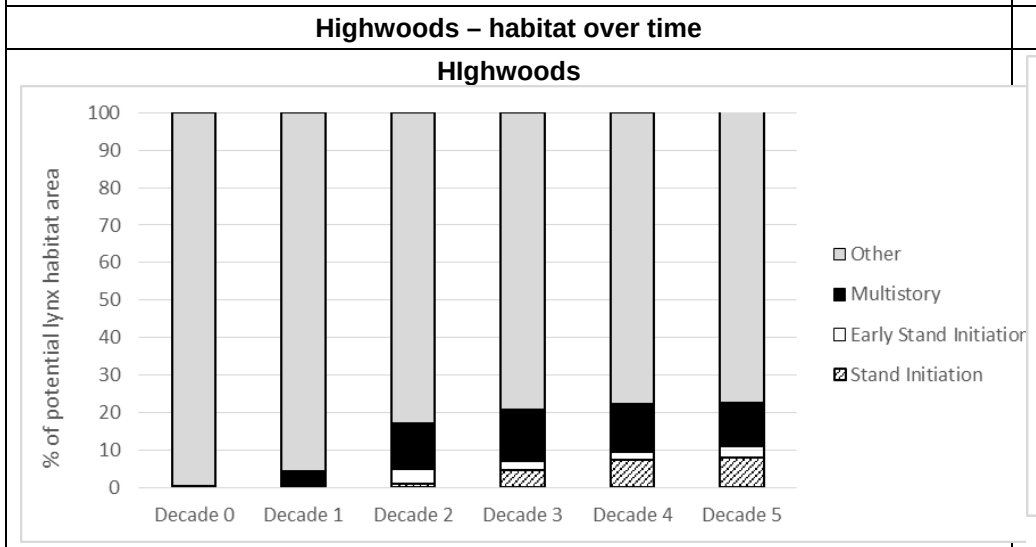


Figure 115. Canada lynx habitat over time, average of all alternatives, by habitat category – Elkhorns and Highwoods GAs







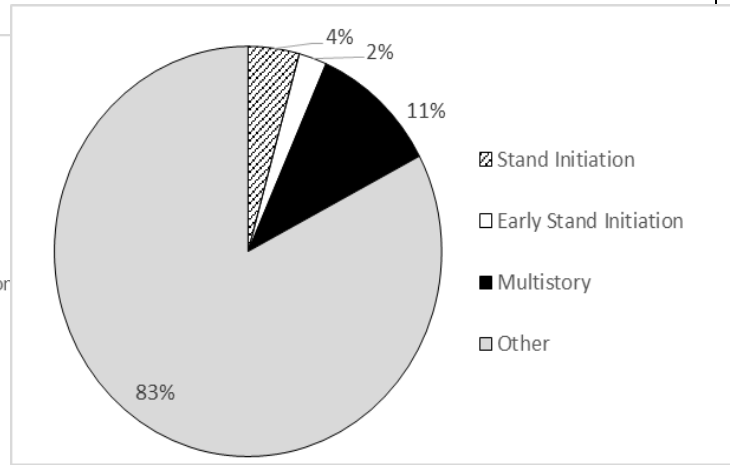


Figure 116. Canada lynx habitat over time, average of all alternatives, by habitat category – Little Belts and Rocky Mountain Range GAs

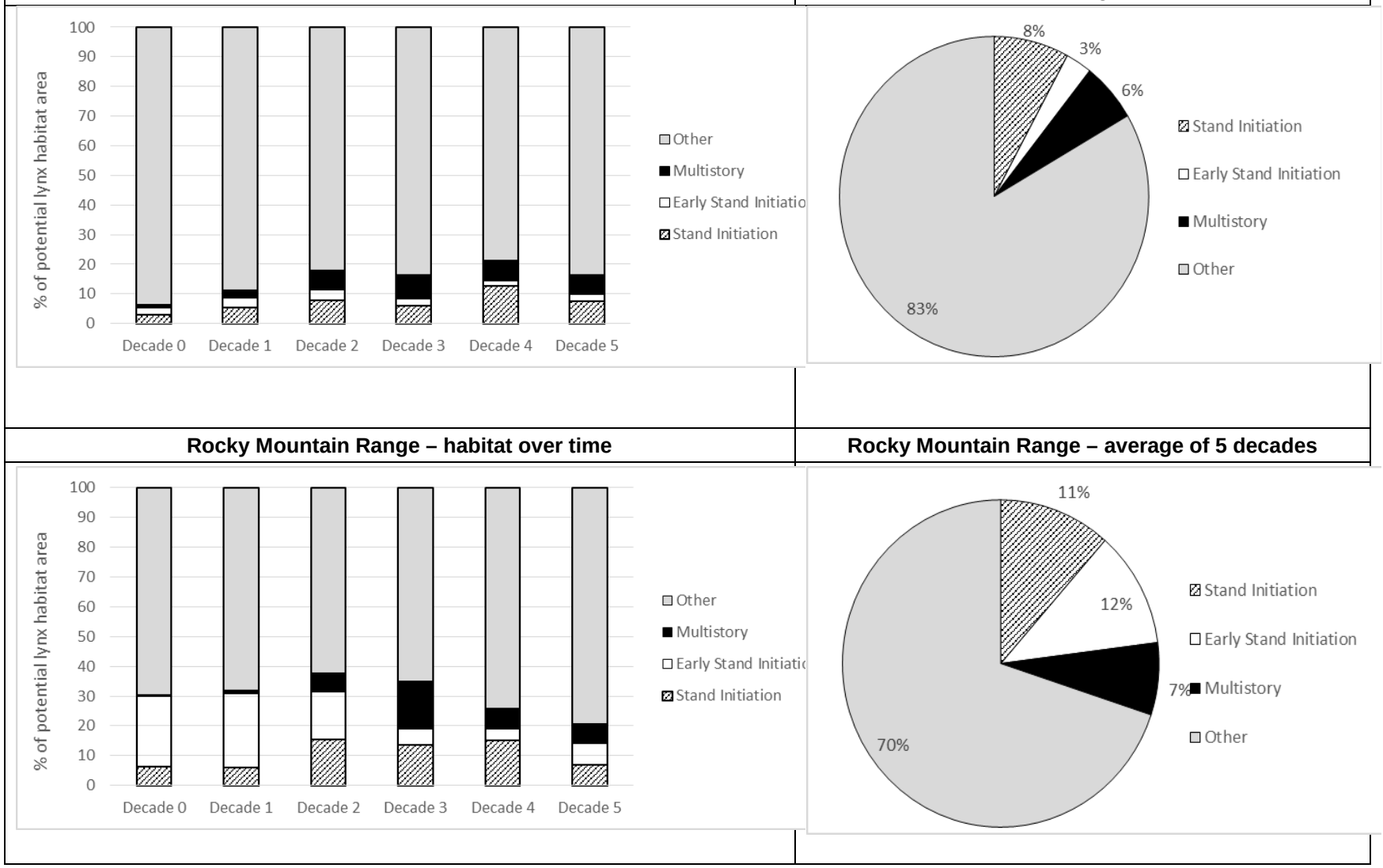


Figure 117. Canada lynx habitat over time, average of all alternatives, by habitat category – Snowies and Upper Blackfoot GAs

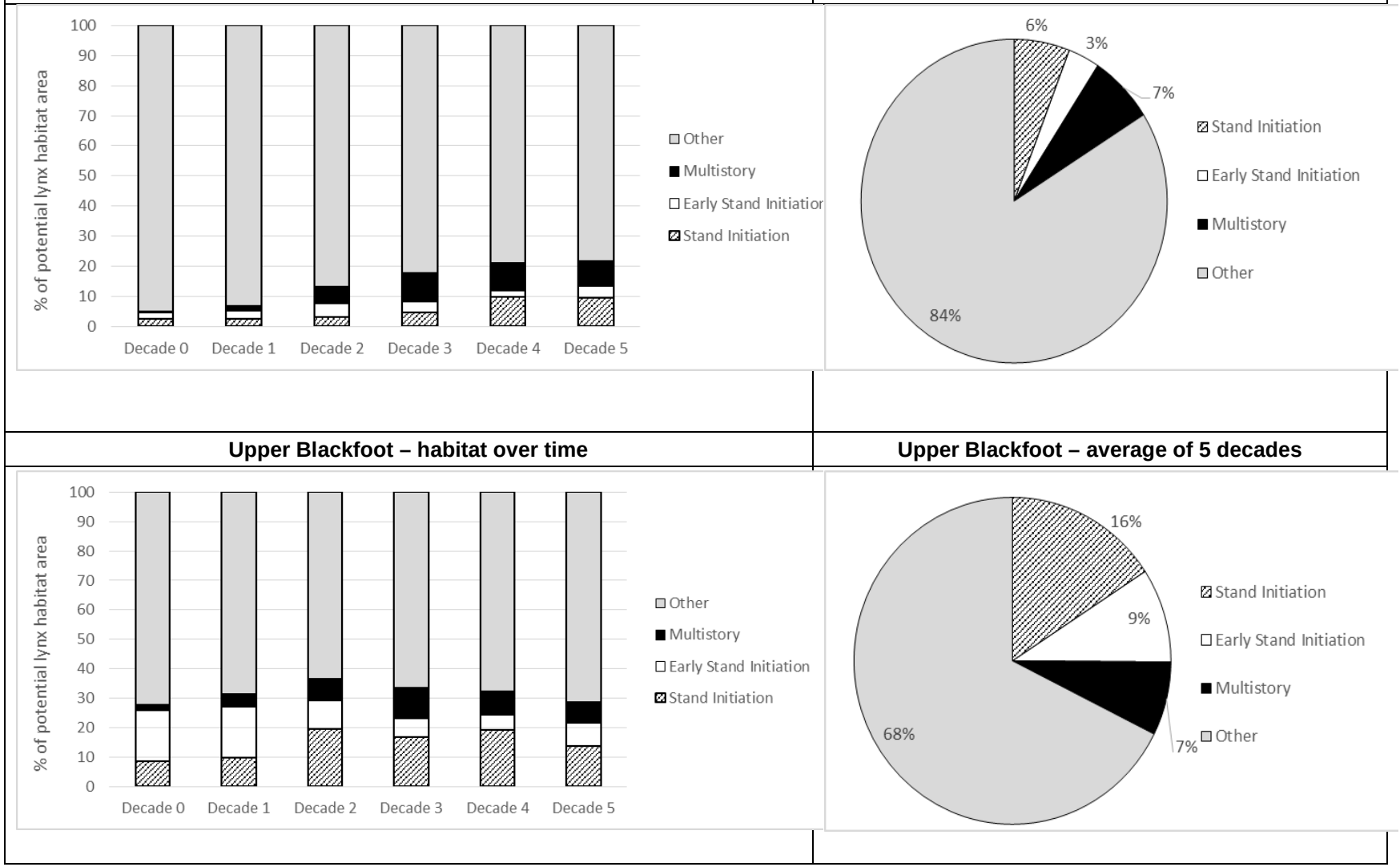


Figure 118. Canada lynx habitat over time compared to NRV by habitat category and alternative - forestwide

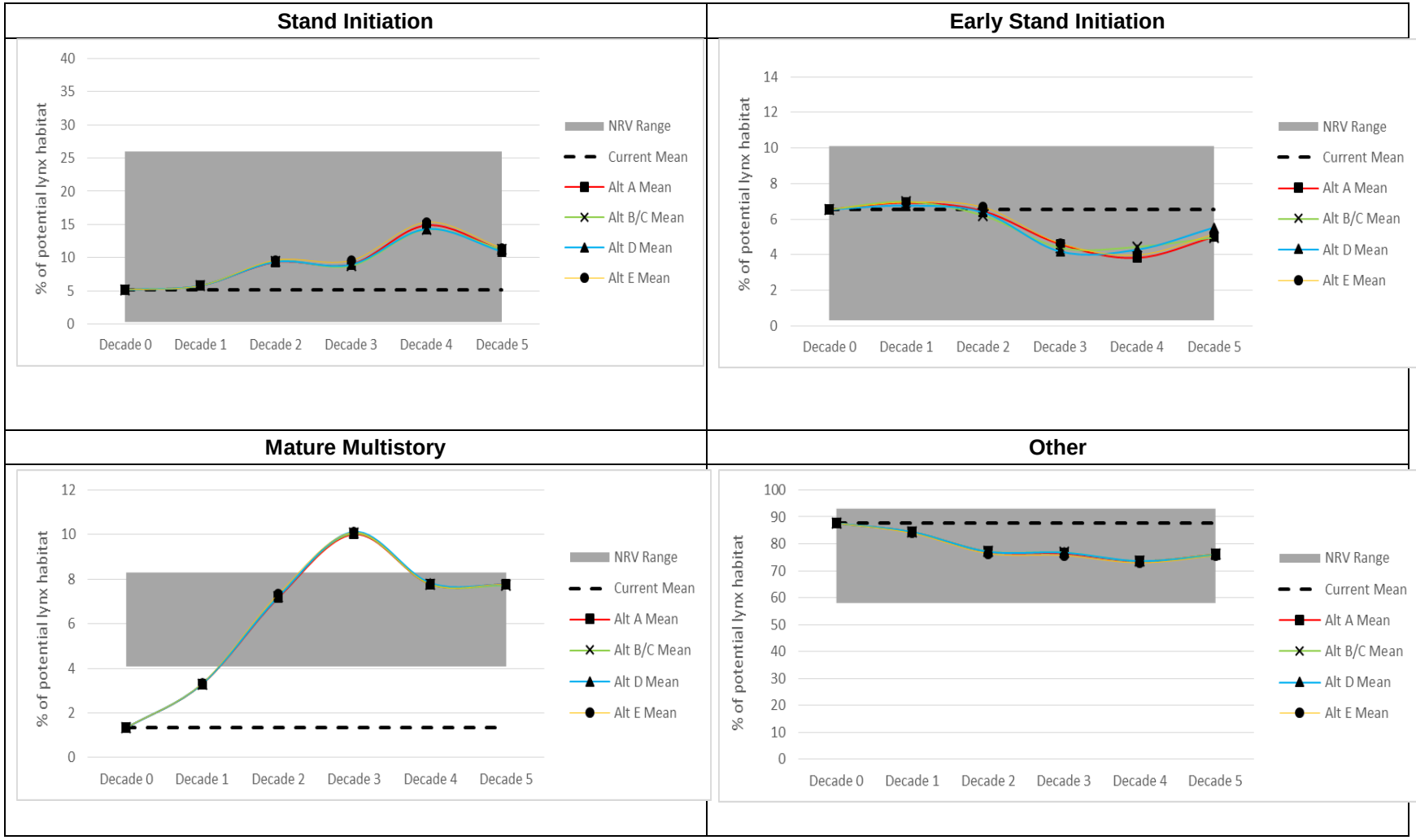
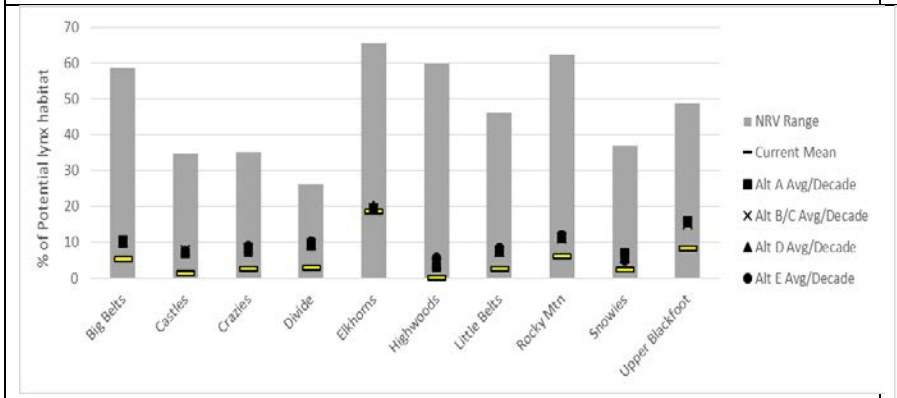
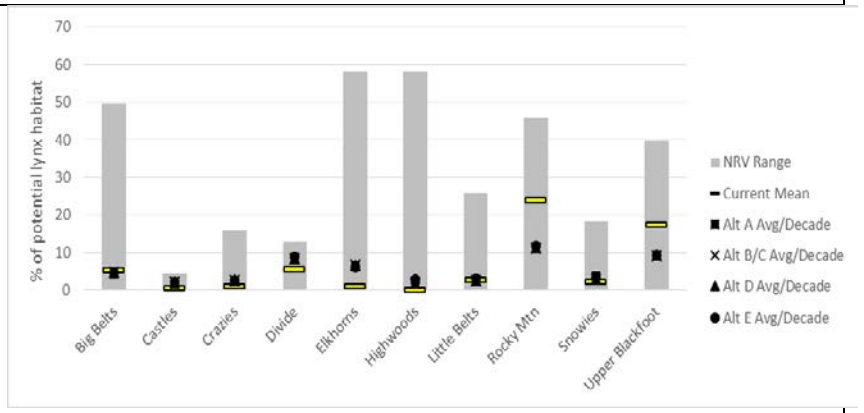


Figure 119. Canada lynx habitat average/decade across 50 years, compared to NRV by habitat category and alternative - GAs

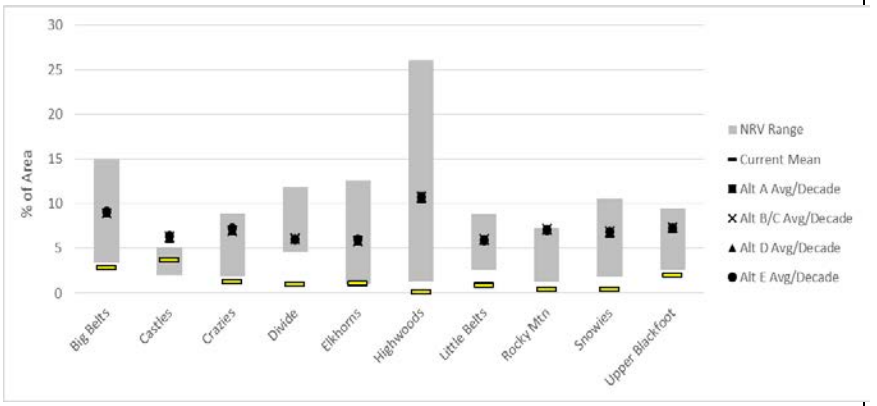
Stand Initiation



Early Stand Initiation



Mature Multistory



Other

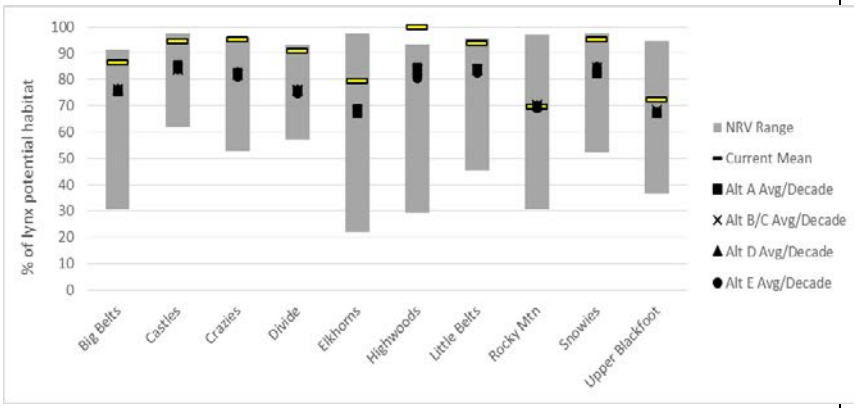


Figure 120. Canada lynx habitat over time compared to NRV by habitat category and alternative – Big Belts GA

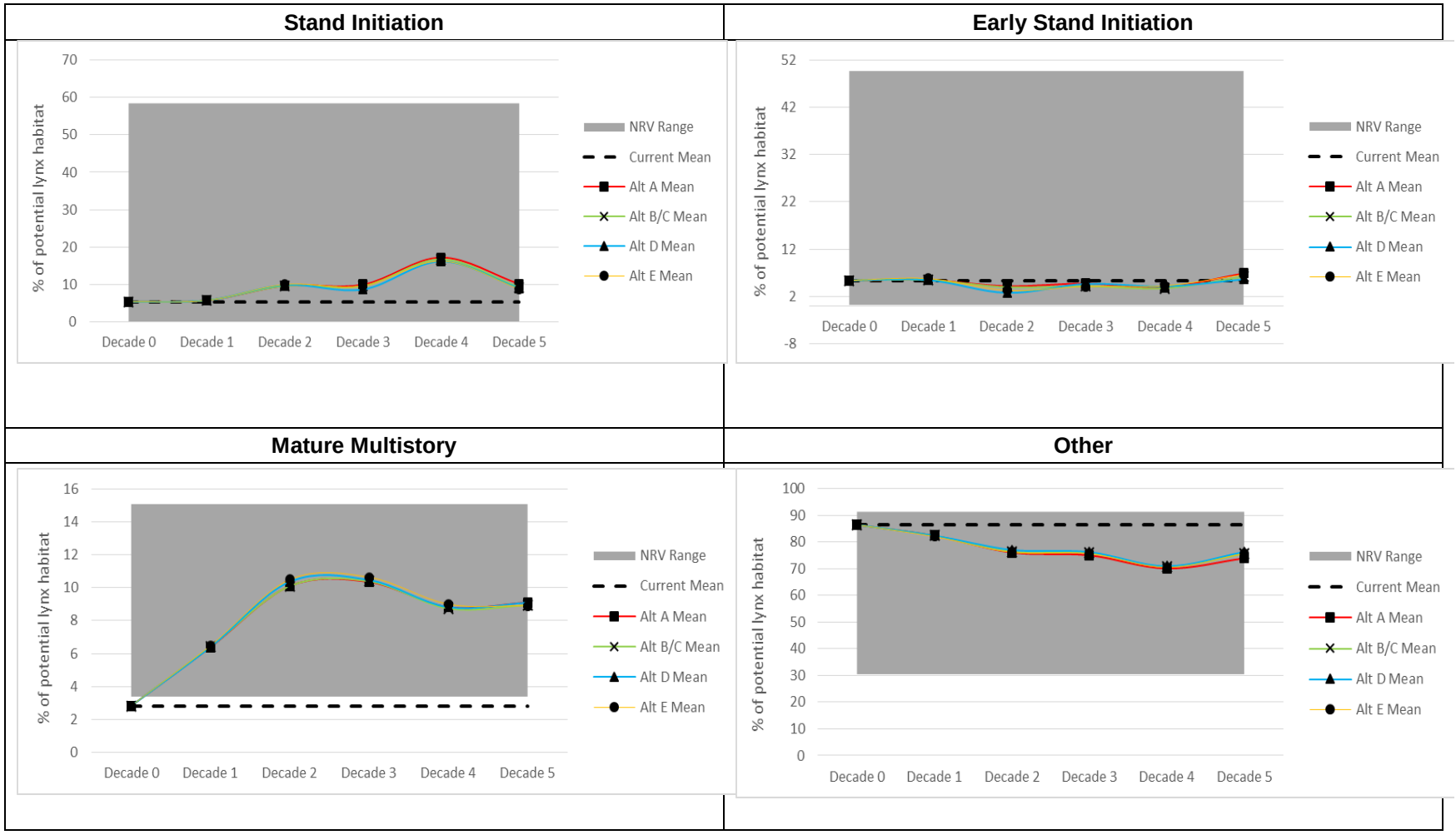


Figure 121. Canada lynx habitat over time compared to NRV by habitat category and alternative – Castles GA

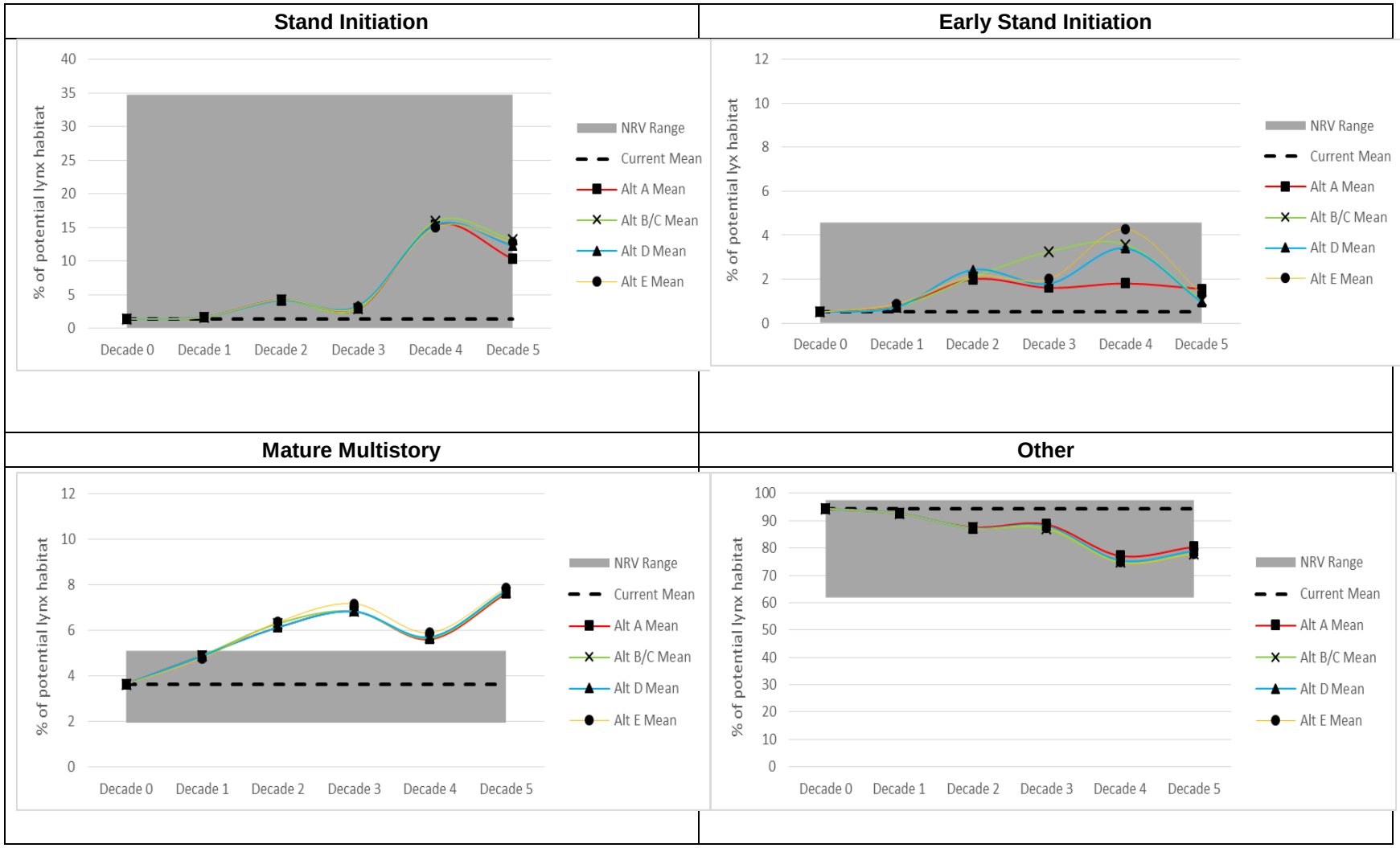


Figure 122. Canada lynx habitat over time compared to NRV by habitat category and alternative – Crazies GA

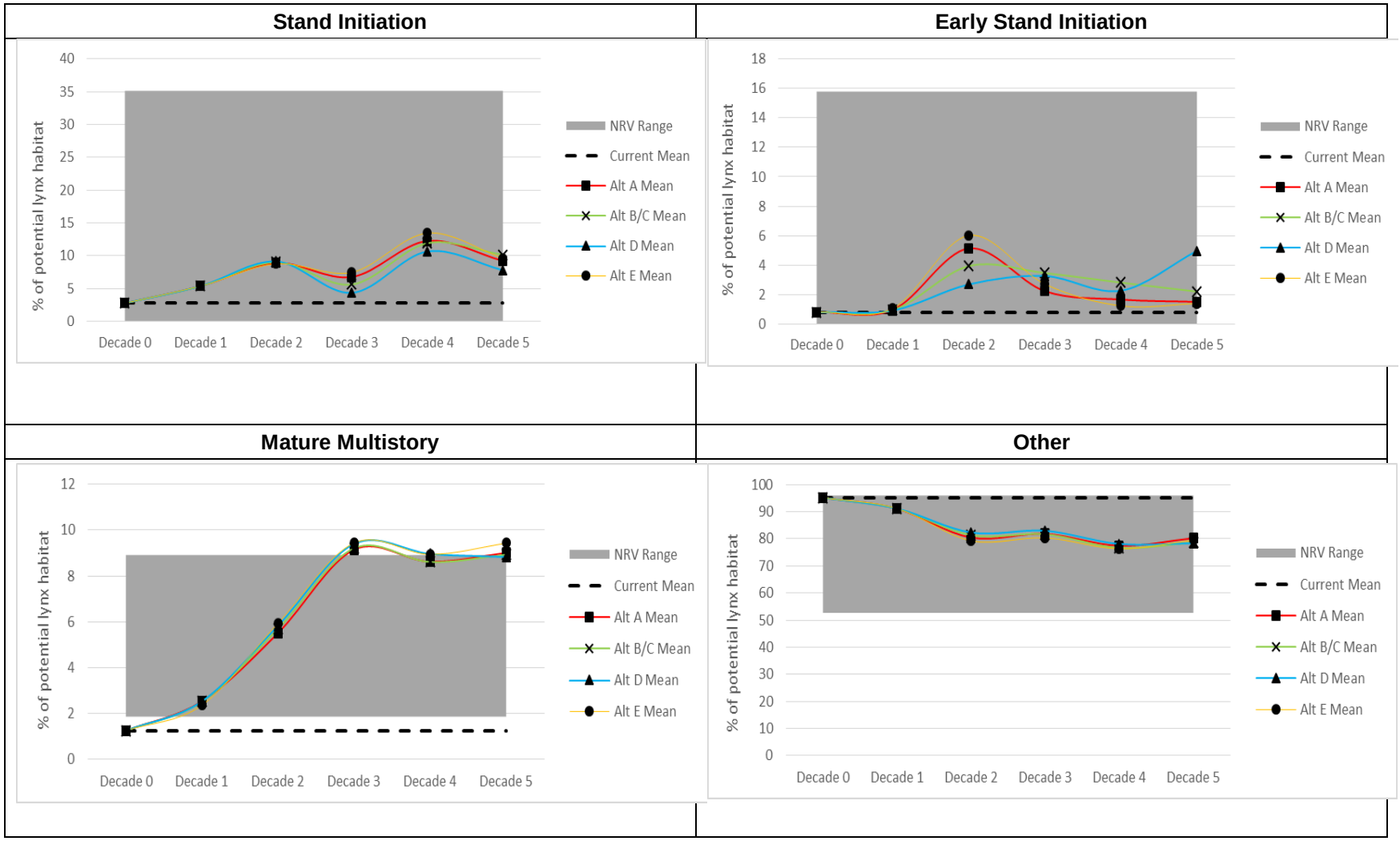


Figure 123. Canada lynx habitat over time compared to NRV by habitat category and alternative – Divide GA

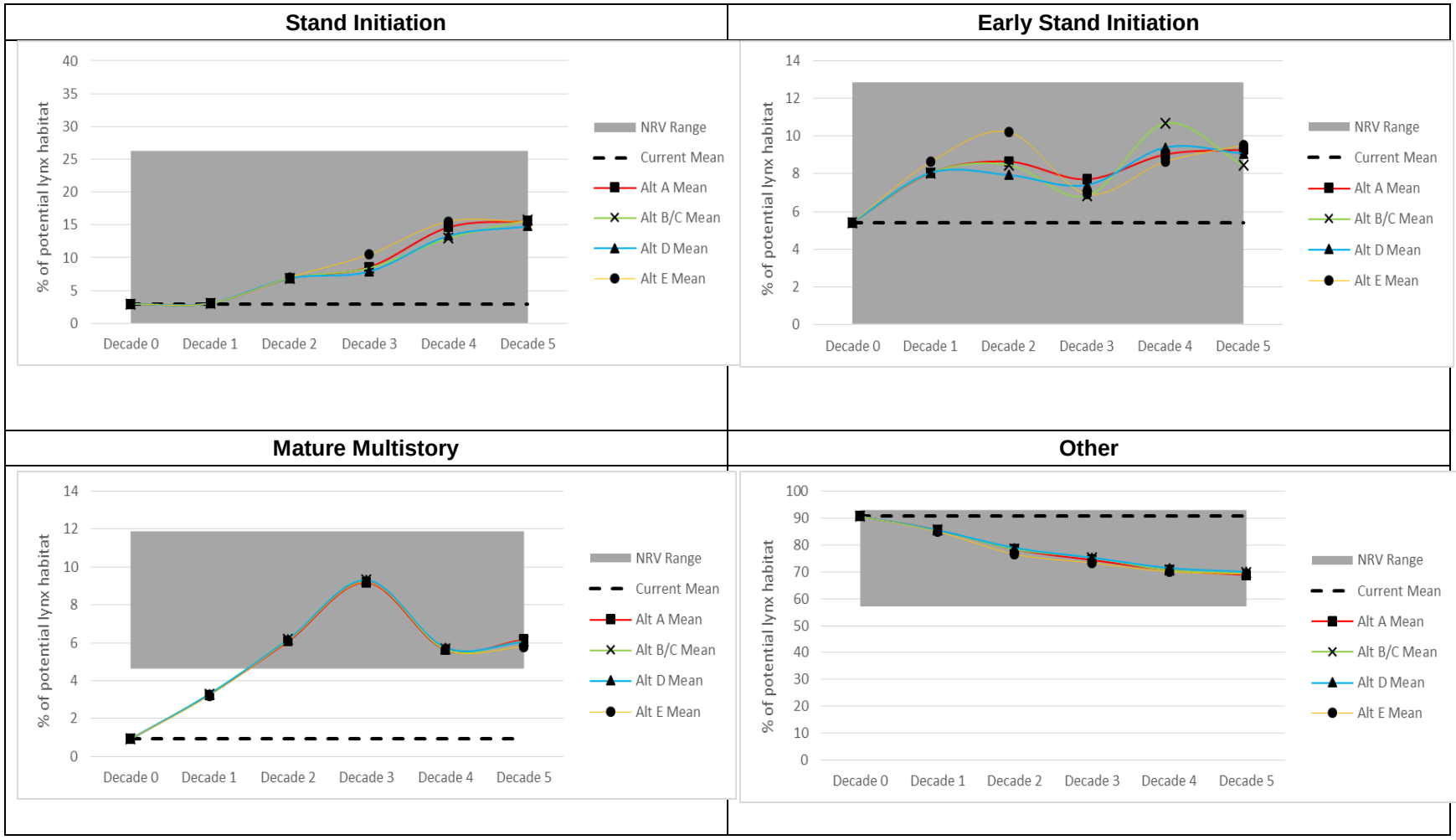


Figure 124. Canada lynx habitat over time compared to NRV by habitat category and alternative – Elkhorns GA

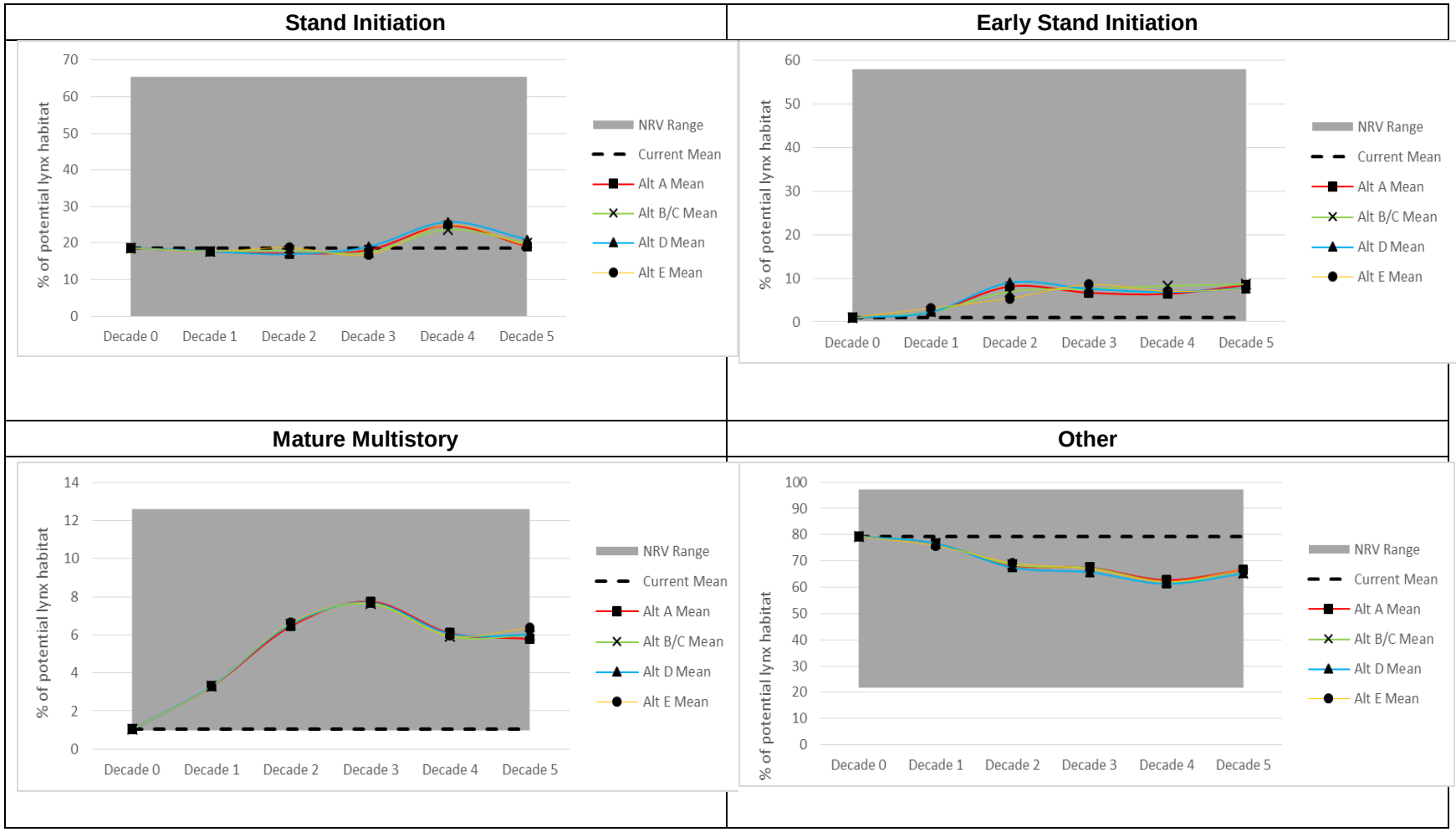


Figure 125. Canada lynx habitat over time compared to NRV by habitat category and alternative – Highwoods GA

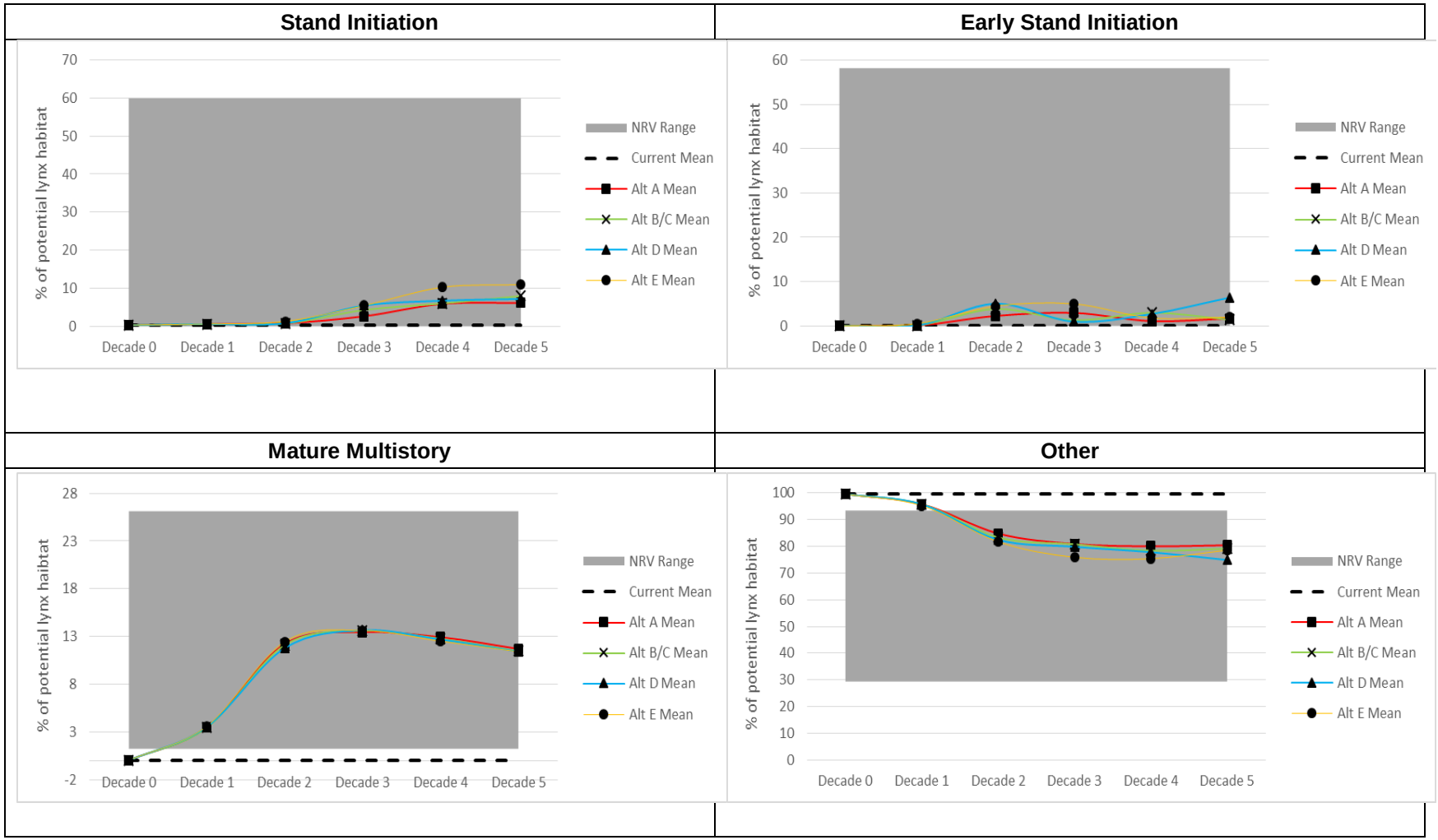


Figure 126. Canada lynx habitat over time compared to NRV by habitat category and alternative – Little Belts GA

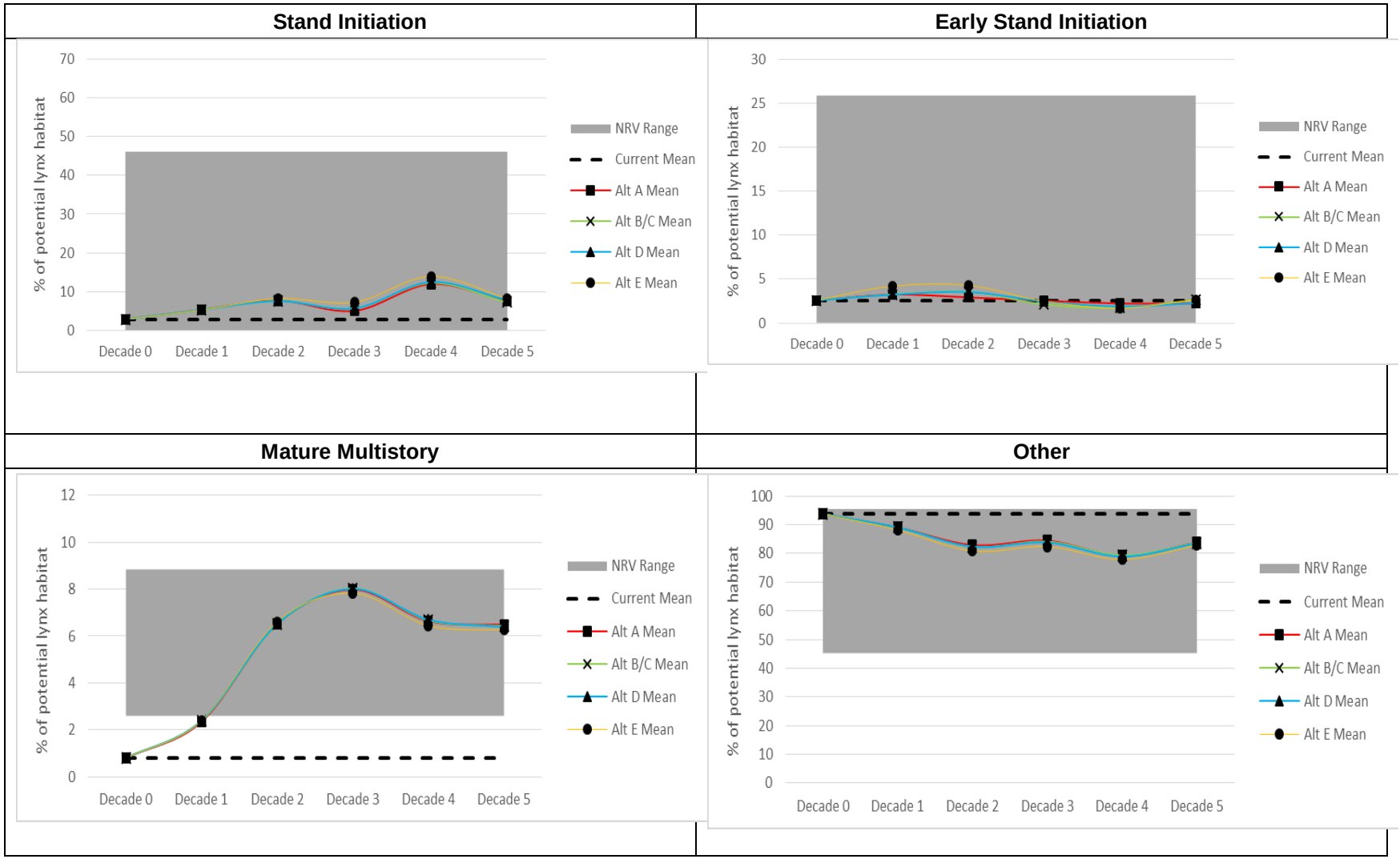


Figure 127. Canada lynx habitat over time compared to NRV by habitat category and alternative – Rocky Mountain Range GA

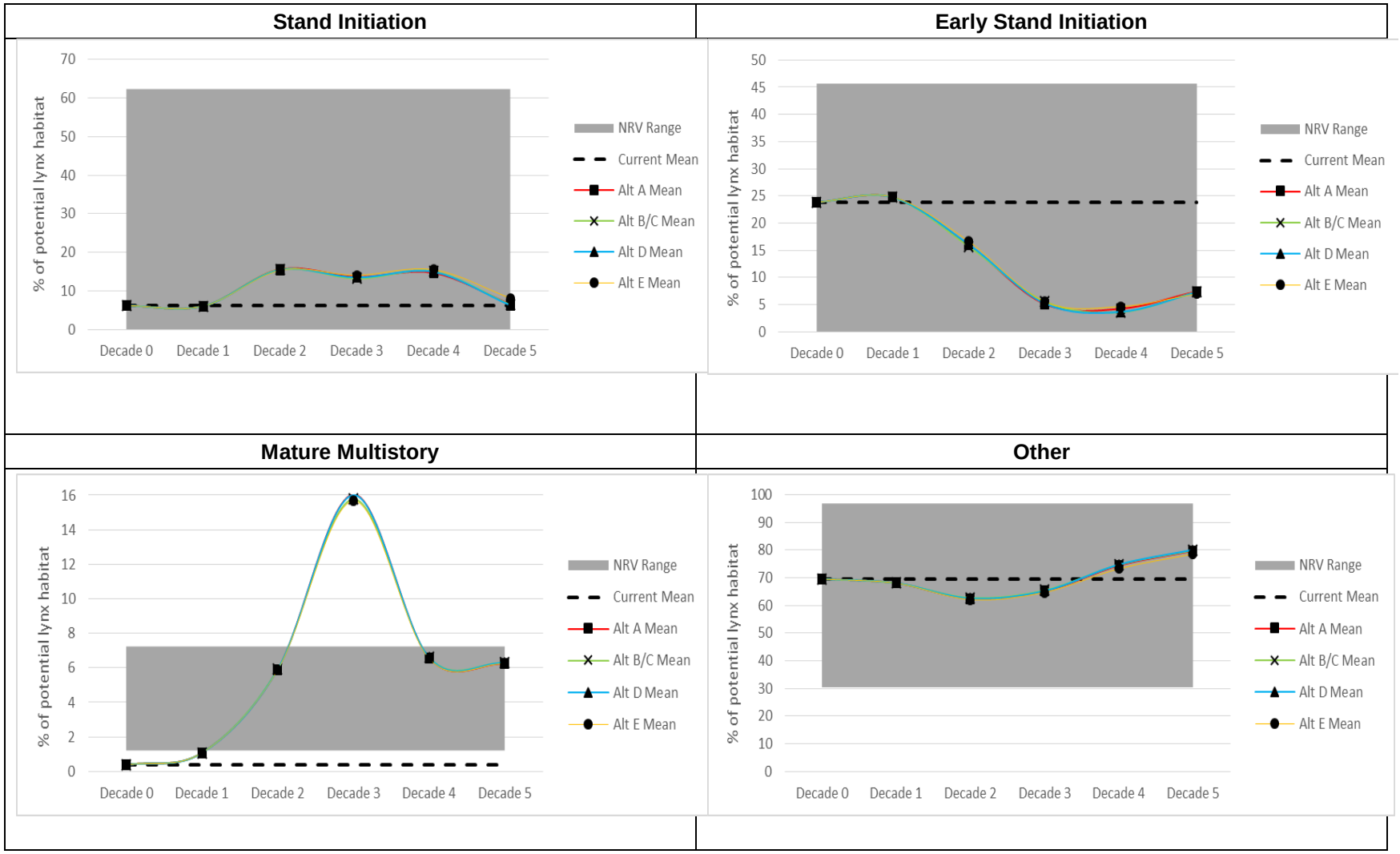


Figure 128. Canada lynx habitat over time compared to NRV by habitat category and alternative – Snowies GA

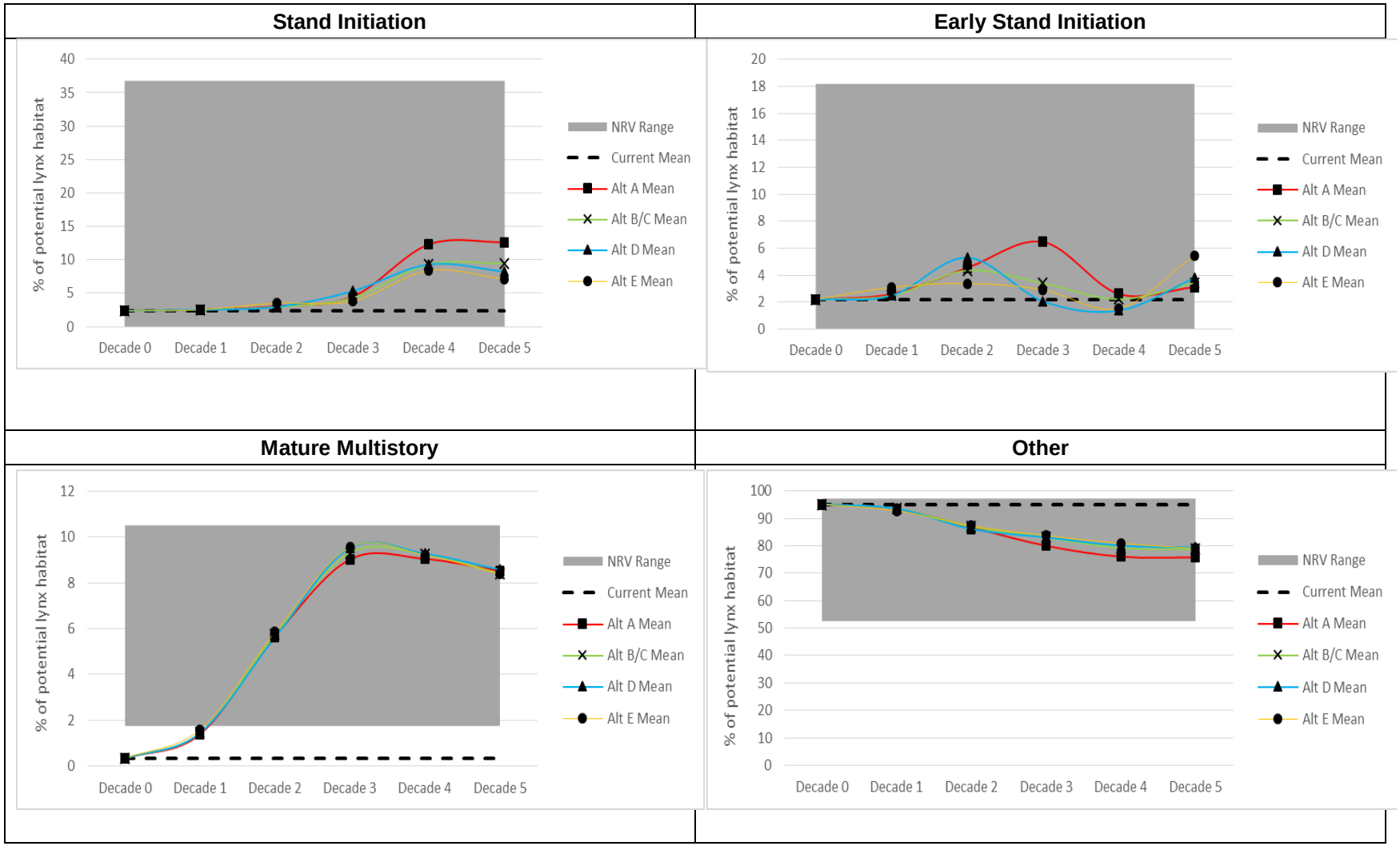
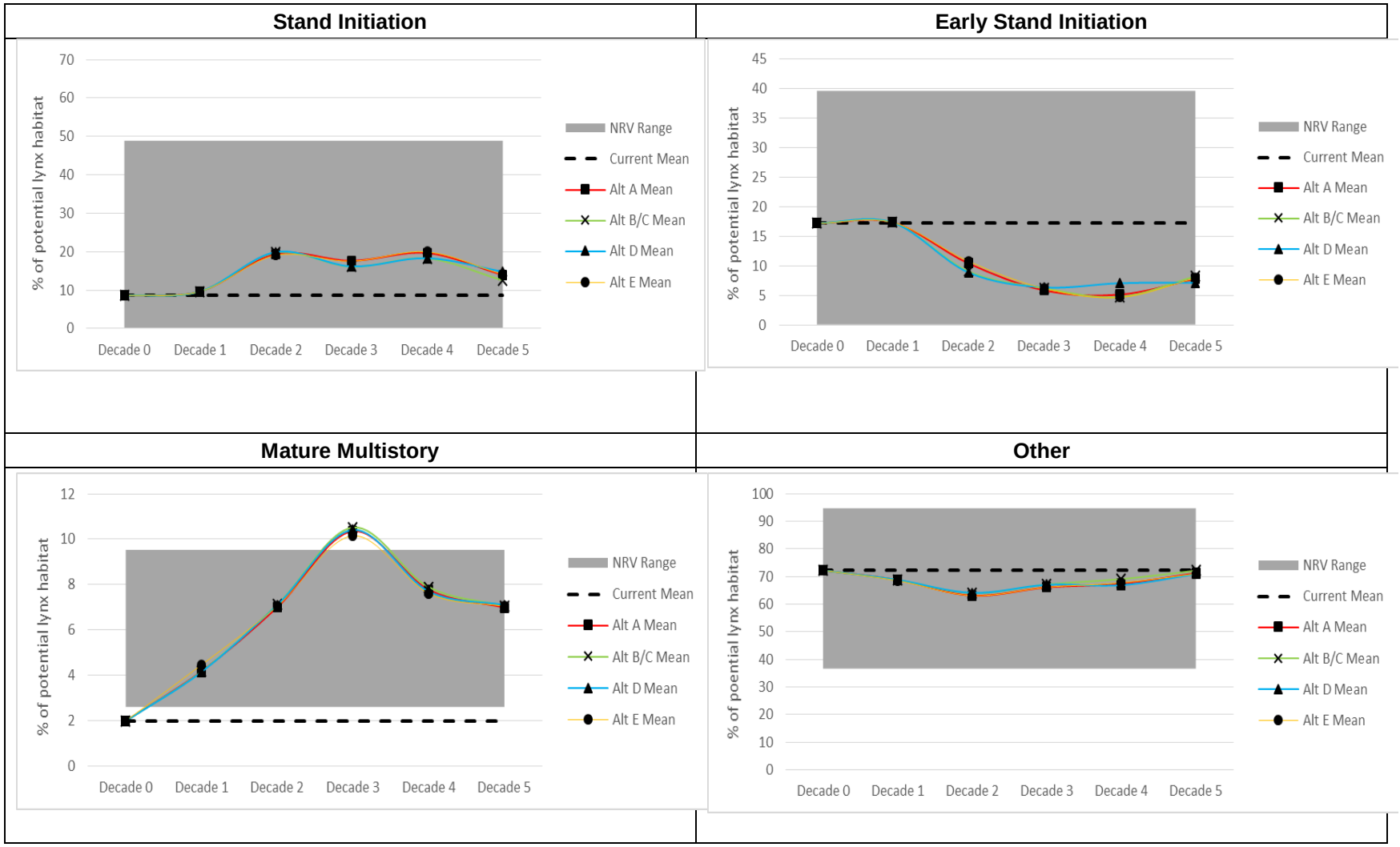


Figure 129. Canada lynx habitat over time compared to NRV by habitat category and alternative – Upper Blackfoot GA



Elk

This section summarizes the information sources and methodology used in the elk analysis. Additional detail can be found in the Elk Background Report in the project file. Information presented in this analysis and in the Elk Background Report comes from field examination of the planning area, inferences from scientific literature, wildlife survey work in in the planning area, geospatial data, and discussions with other state and federal biologists.

The existing forest plans are described to provide context for the environmental consequence section. Note that both the Helena and Lewis and Clark Forest plans include management area requirements specific to elk. For the purposes of this analysis, however, only Forest-wide requirements are included.

The USFS and MTDFWP Collaborative Recommendations for Big Game Habitat Management on the Custer, Gallatin, Helena, and Lewis and Clark National Forests (U.S. Department of Agriculture, Forest Service and Montana Department of Fish,, Wildlife & Parks, 2013) is also used because this paper reflects the efforts of wildlife biologists from the FS and MDFWP to use the best contemporary information and their collective experiences in managing elk and elk habitat to address current issues and conditions on the referenced NFs.

Habitat-related data are presented according to metrics identified in (1) the 1986 Helena NF Plan; (2) the 1986 Lewis and Clark NF Plan; and (3) the U.S. FS and MTDFWP Collaborative Recommendations for Big Game Habitat Management on the Custer, Gallatin, Helena, and Lewis and Clark National Forests. All vegetation data are based on R1-VMap. R1-VMap data are remotely sensed and represent a broad-scale, coarse filter depiction that is classified into vegetation components such as canopy cover, tree dominance type, and size class. Refer to the Elk Background Report in the project file for additional details regarding habitat mapping and estimation.

Helena National Forest Plan

The following methods and information have been used to describe the existing condition for elk habitat under the current Helena NF Plan.

- Elk herd units serve as the basis for the analysis; these have been developed in conjunction with MTDFWP.
- Summer range comprises the entire elk herd unit. Winter range is based on updated MTDFWP range maps (2008).
- Hiding cover is based on the MTDFWP definition; both hiding cover and thermal cover are summarized in the Elk Background Report in the project file.
- Road density information is derived from transportation database. Assumptions made regarding which roads are included in calculations of density are detailed in the Elk Background Report in the project file.

Lewis and Clark Forest Plan

The following methods and information have been used to describe the existing condition for elk habitat under the current Lewis and Clark NF Plan. See also the *Process for Analyzing Big Game Cover*, 2016.

- Sixth and 7th code subwatersheds (ranging from 3,000 acres to 40,000 acres) serve as the basis for the cover analysis under the Lewis and Clark plan.
- Vegetation data are used to develop the photo interpretive (PI) types as defined in the Montana Cooperative Elk/Logging Study (Lyon et al., 1985). Vegetation data from R1-VMap (refer to information in the Elk Background Report in the project file) has been used to assign PI type.

- Effective hiding cover is based on the "Montana Rule" that assigns a hiding cover percent to specific stand characteristics.

USDA FS and MTDFWP 2013

The following methods and information have been used to describe the existing condition for elk habitat according to the U.S. Forest Service and Montana Department of Fish, Wildlife, and Parks Collaborative Recommendations for Big Game Habitat Management on the Custer, Gallatin, Helena, and Lewis and Clark National Forests (U.S. Department of Agriculture, Forest Service and Montana Department of Fish,, Wildlife & Parks, 2013).

- The geographic area serves as the basis for the analysis.
- Elk security analysis is based on motorized routes (roads and trails). Definitions of elk security areas are in the collaborative recommendation paper cited above, and are described in the Elk Background Report in the project file.
- Elk spring/summer/fall cover is determined primarily by tree canopy cover in certain tree dominance types, and elk winter cover is based on tree canopy cover. Refer to the collaborative recommendation paper cited above, and the Elk Background Report in the project file.

Elk Population Data

Elk survey data are provided by MTDFWP area biologists for the respective hunting districts (MFWP 2002 – 2016, where available). Elk analyses are also based on the Montana Statewide Elk Management Plan (Montana Fish and Wildlife and Parks, 2004). Elk harvest reports from 2004 to 2016 are located at http://fwp.mt.gov/hunting/planahunt/harvestReports.html

SIMPPLLE model results for elk

Elk hiding cover spring/summer/fall is represented by the proportion of land in forested potential vegetation types dominated by select forest types, with 40-60% canopy cover. Elk hiding cover winter is represented by the proportion of land in forested potential vegetation types dominated by select forest types that occur in mapped elk winter range.

The following series of figures display the SIMPPLLE modeling results for elk hiding cover for each alternative, over a 50-year analysis period, to supplement the information and conclusions presented in the body of the DEIS.

Figure 130. Elk spring/summer/fall hiding cover forestwide, average acres/decade for 50 years compared to NRV by alternative

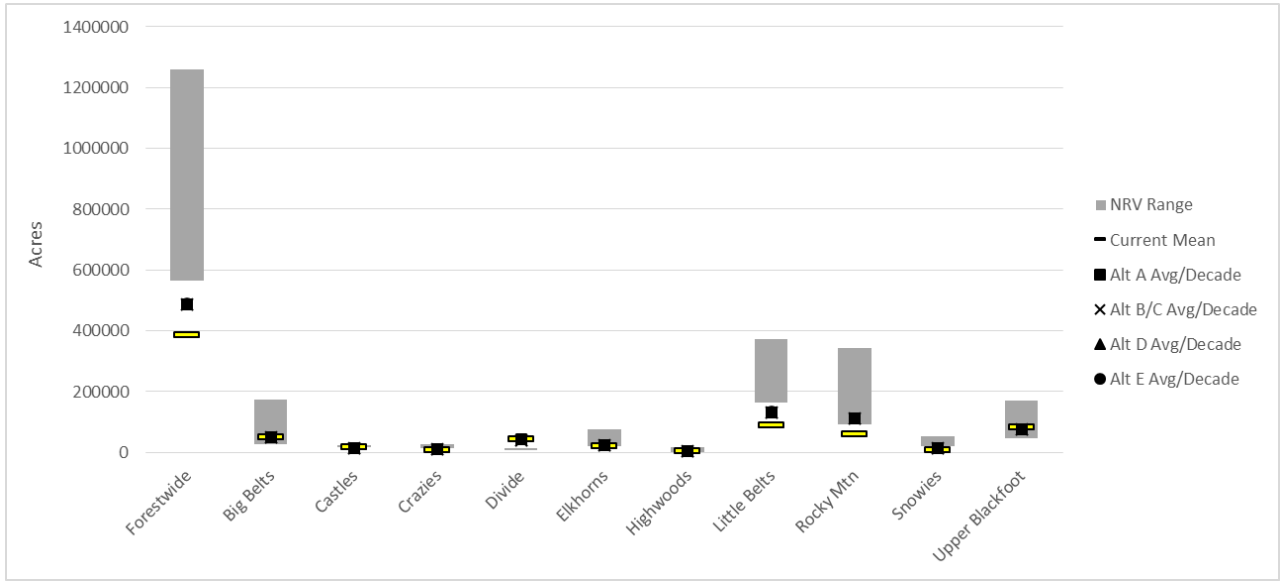


Figure 131. Elk spring/summer/fall hiding cover forestwide over time by alternative

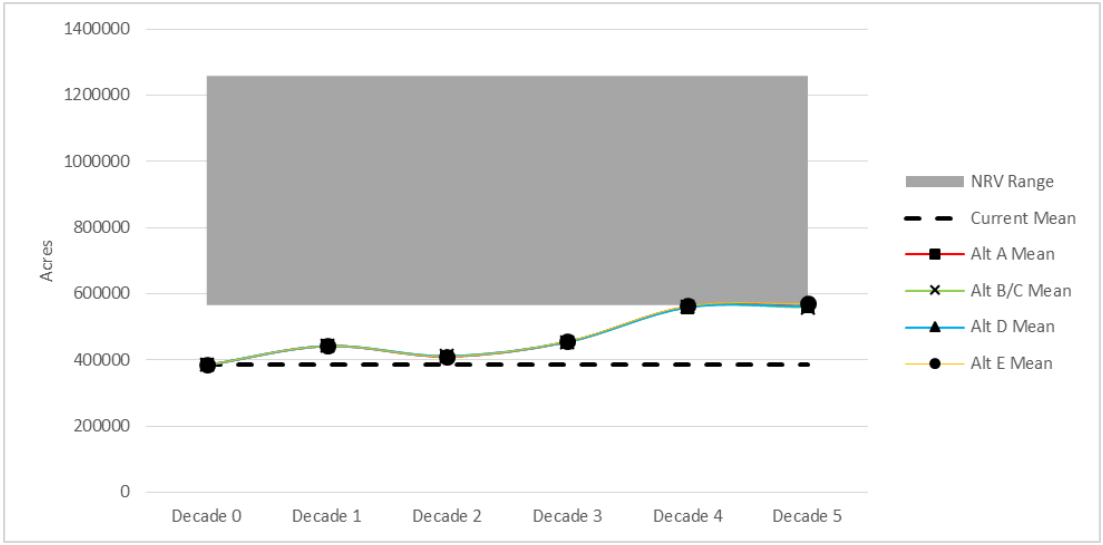


Figure 132. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years – Big Belts GA

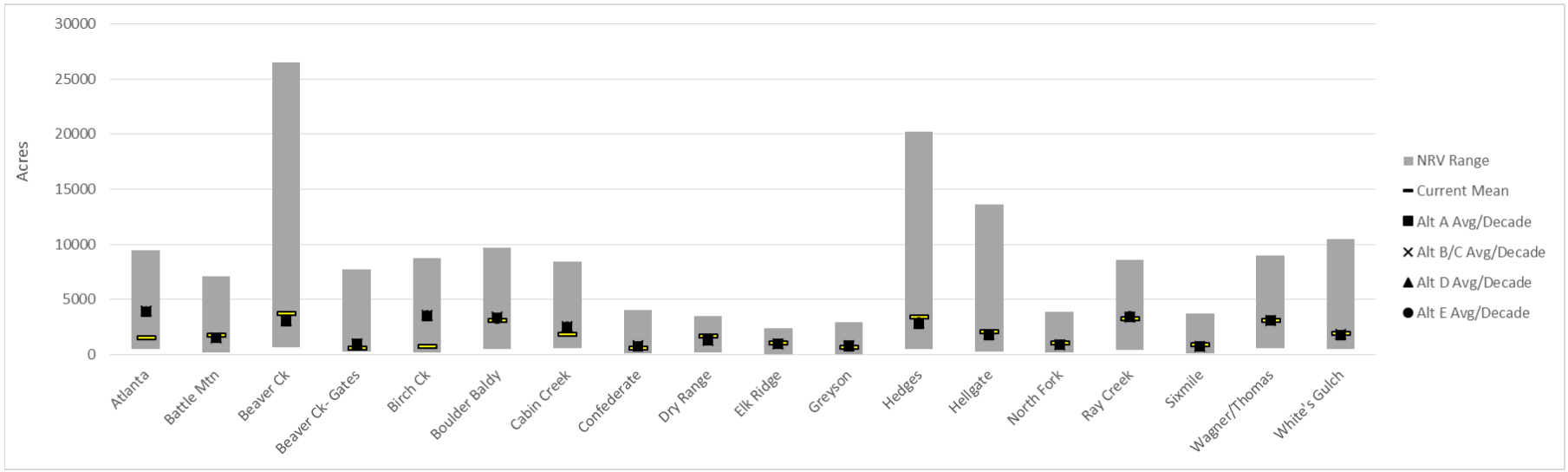


Figure 133. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years - Castles GA

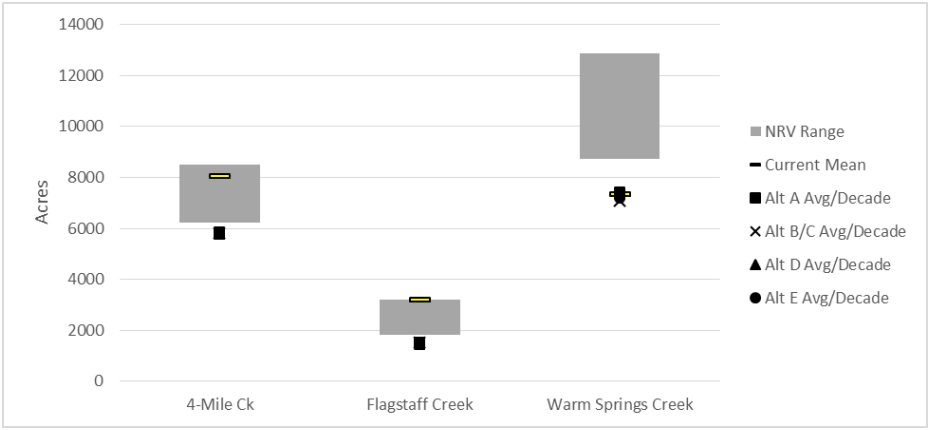


Figure 134. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years - Crazies GA

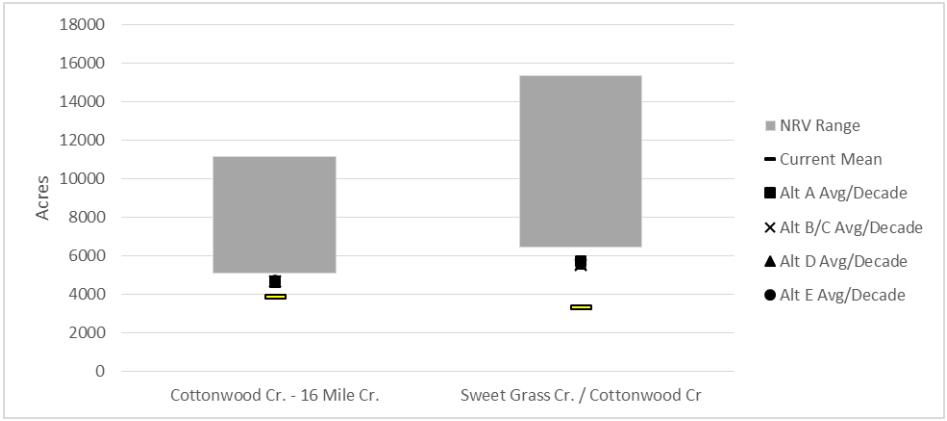


Figure 135. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years - Divide GA

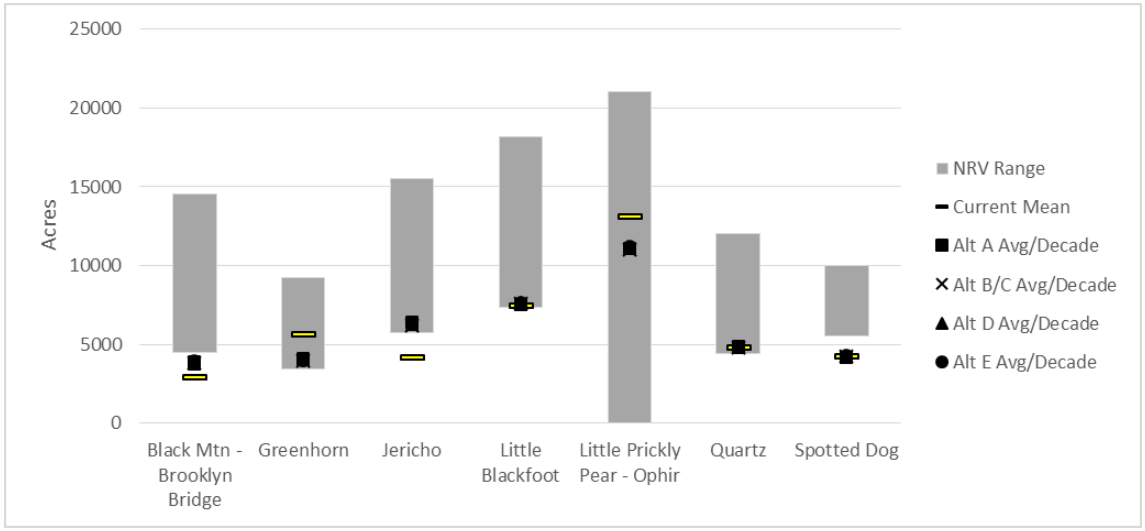


Figure 136. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years - Elkhorns GA

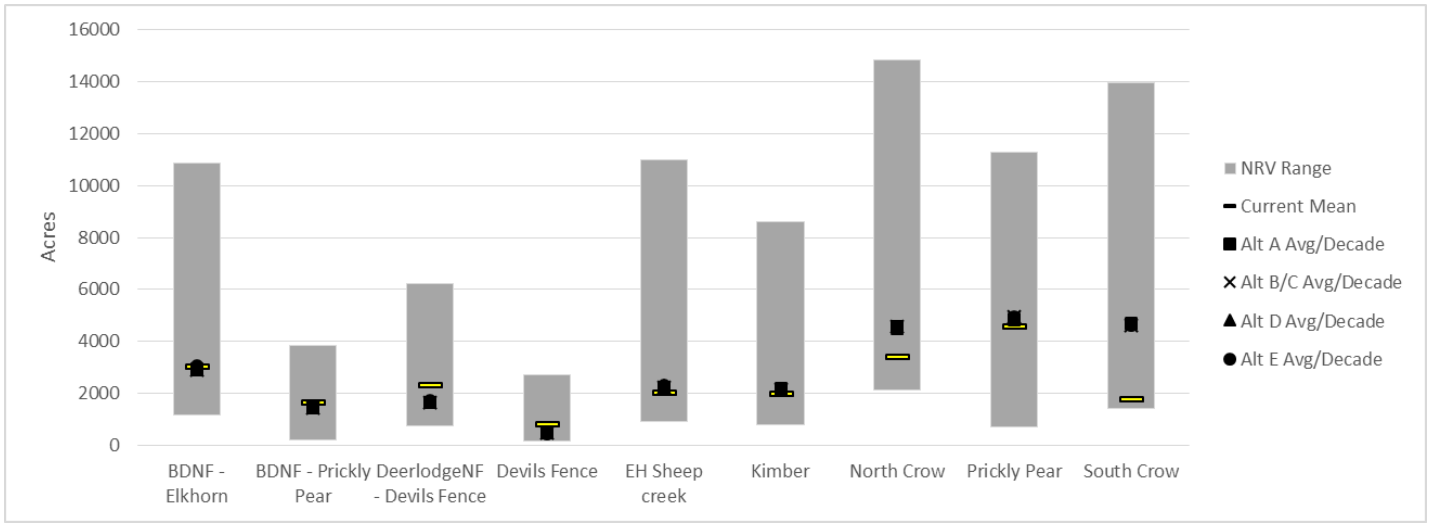


Figure 137. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years - Highwoods GA



Figure 138. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years – Little Belts GA

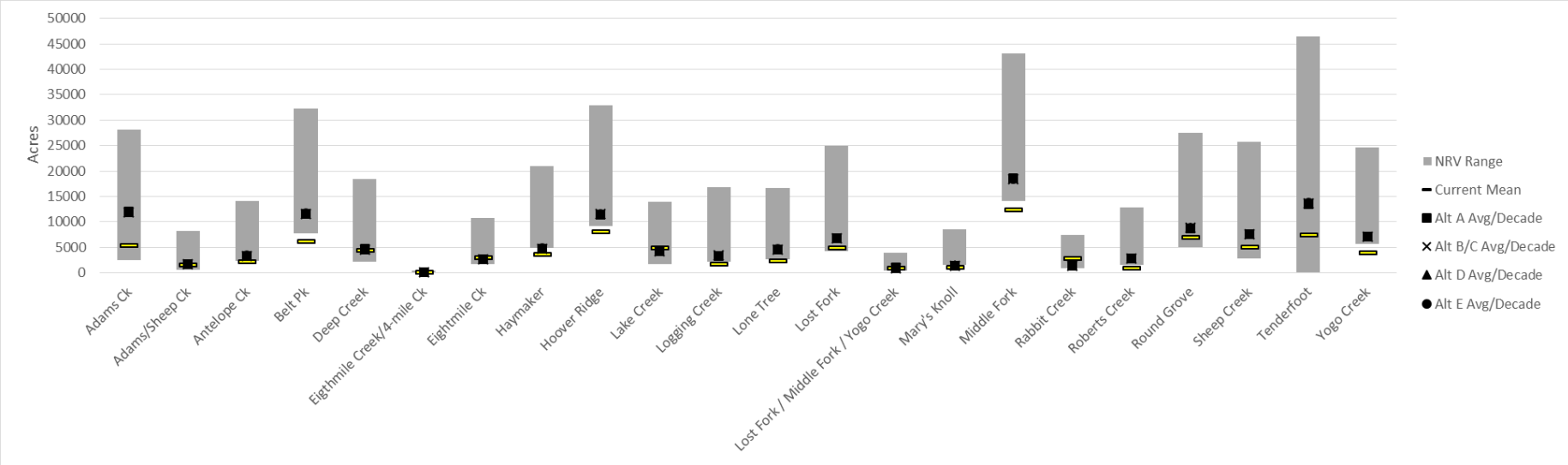


Figure 139. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years – Rocky Mountain Range GA

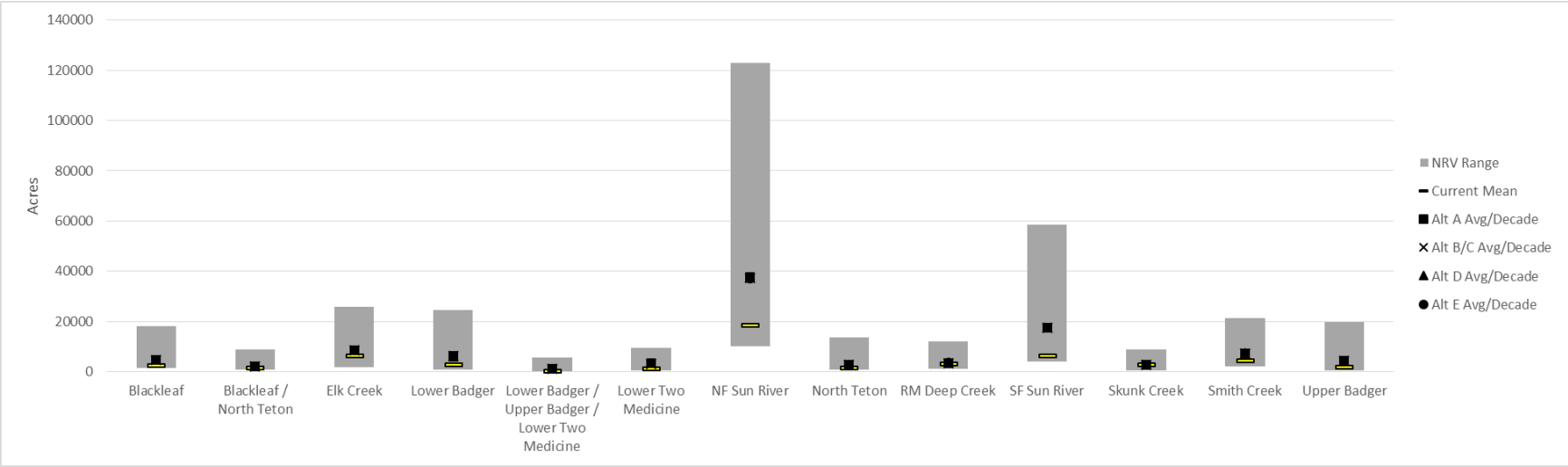


Figure 140. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years – Snowies GA

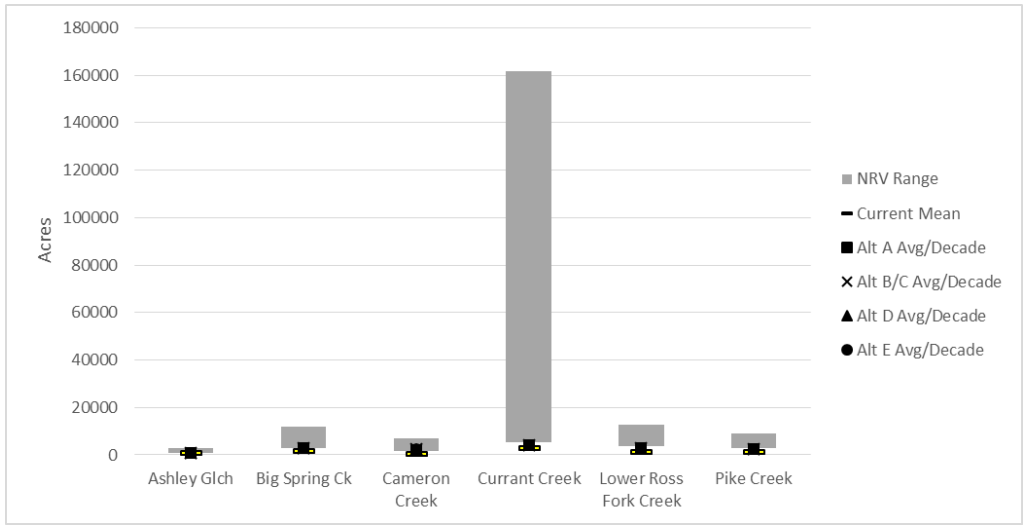


Figure 141. Elk spring/summer/fall hiding cover by elk analysis unit by alternative – average acres/decade across 50 years – Upper Blackfoot GA

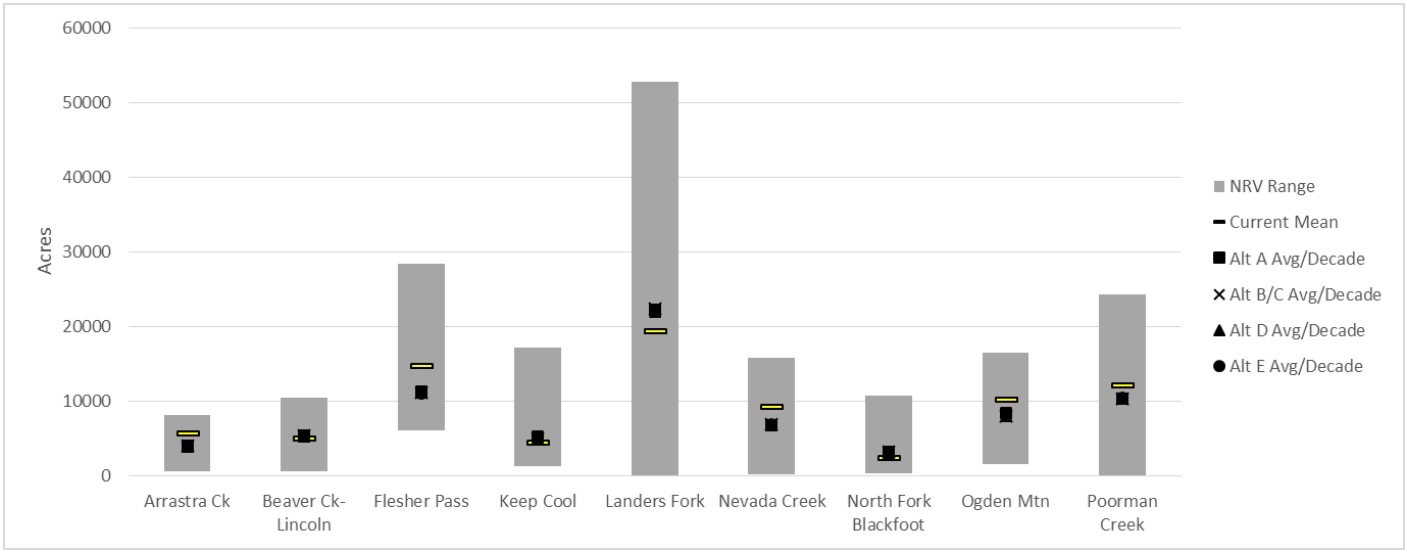


Figure 142. Elk winter habitat forestwide, average acres/decade for 50 years compared to NRV by alternative

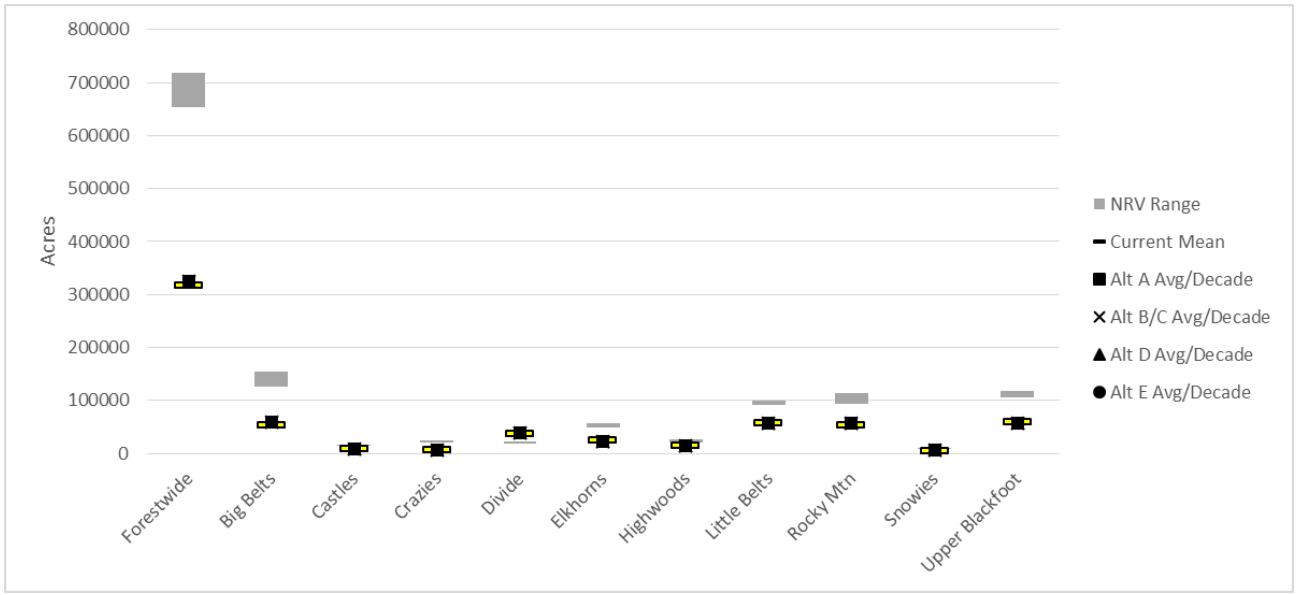


Figure 143. Elk winter habitat over time by alternative forestwide

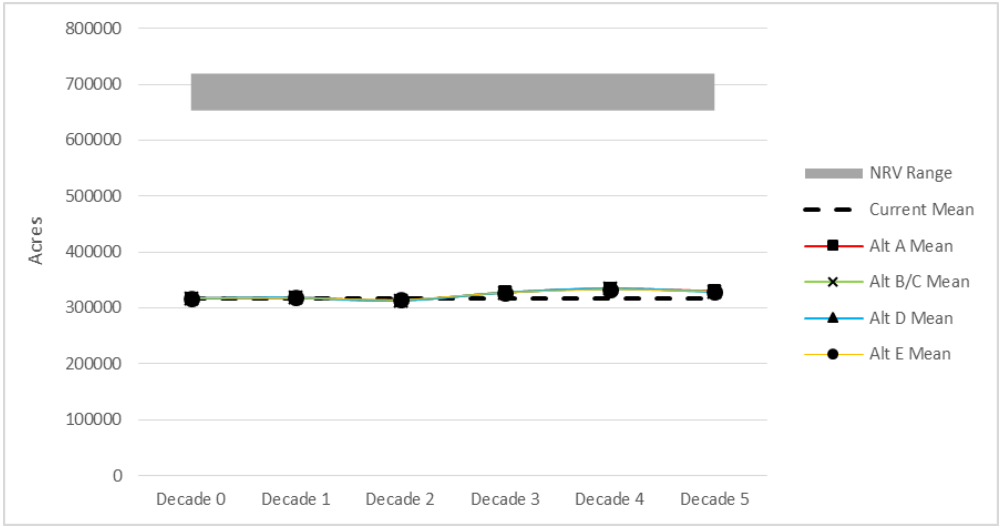


Figure 144. Elk winter habitat by GA over time by alternative – Big Belts, Castles, Crazies, and Divide GAs

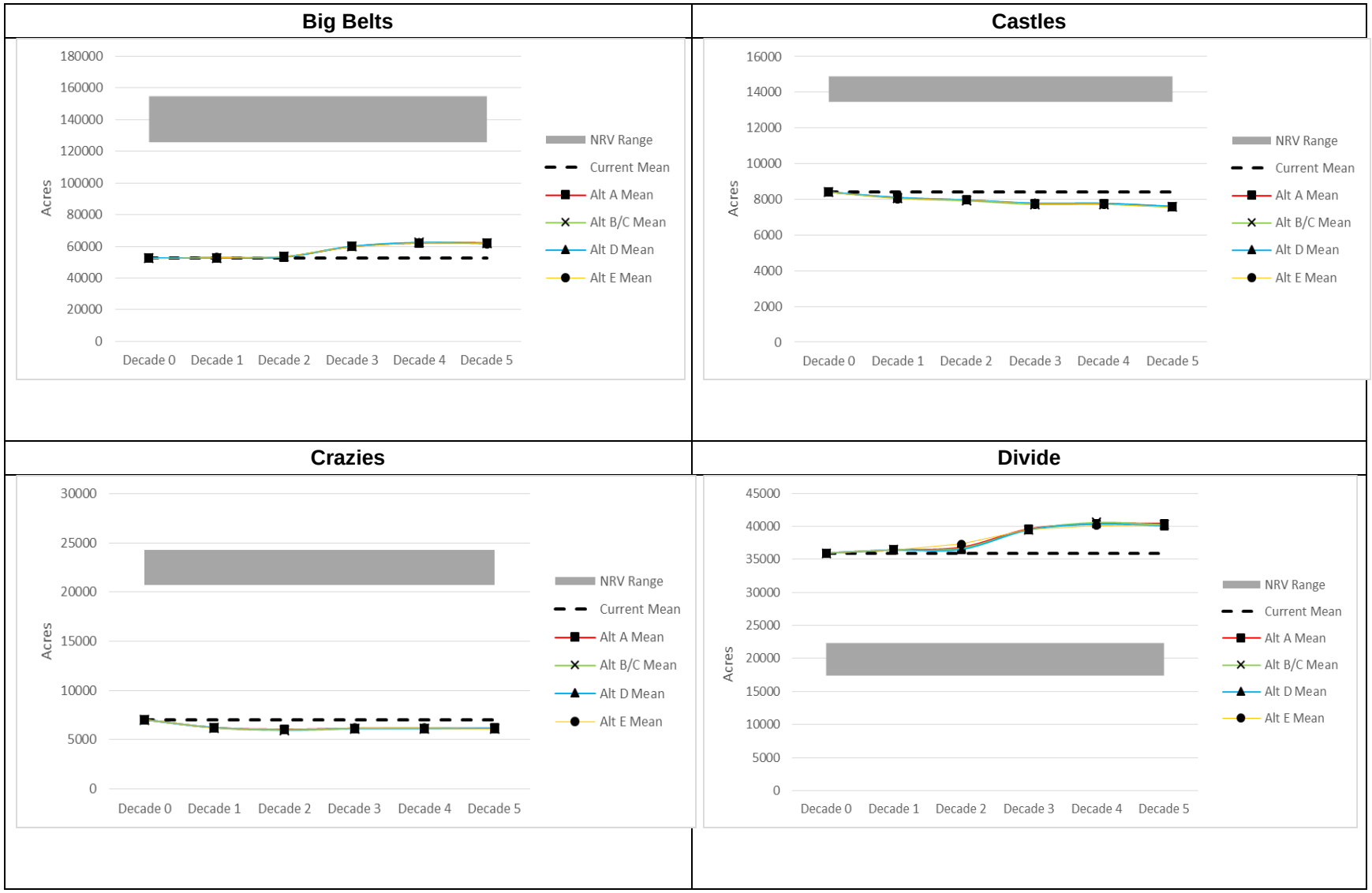


Figure 145. Elk winter habitat by GA over time by alternative – Elkhorns, Highwoods, Little Belts, and Rocky Mountain Range GAs

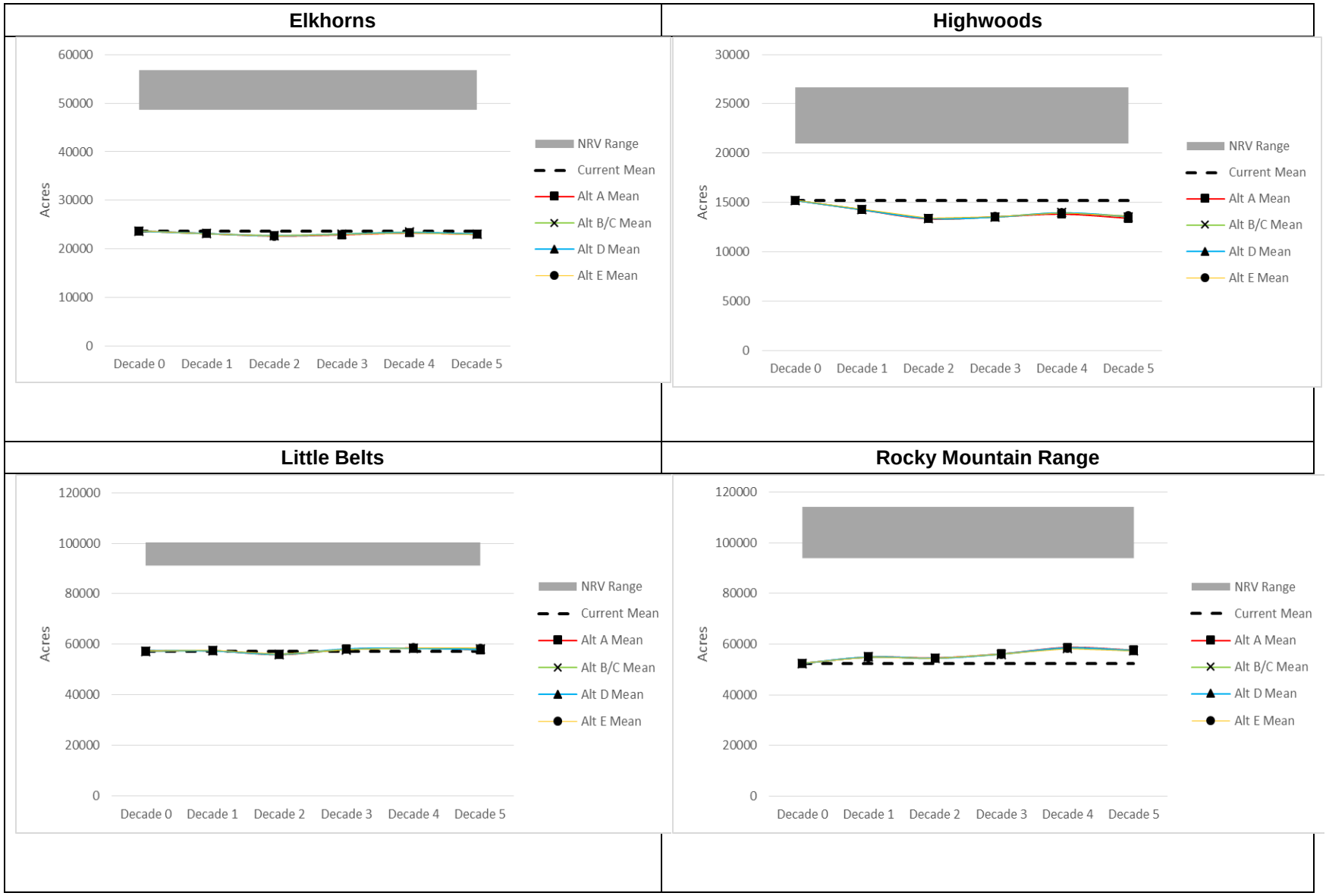
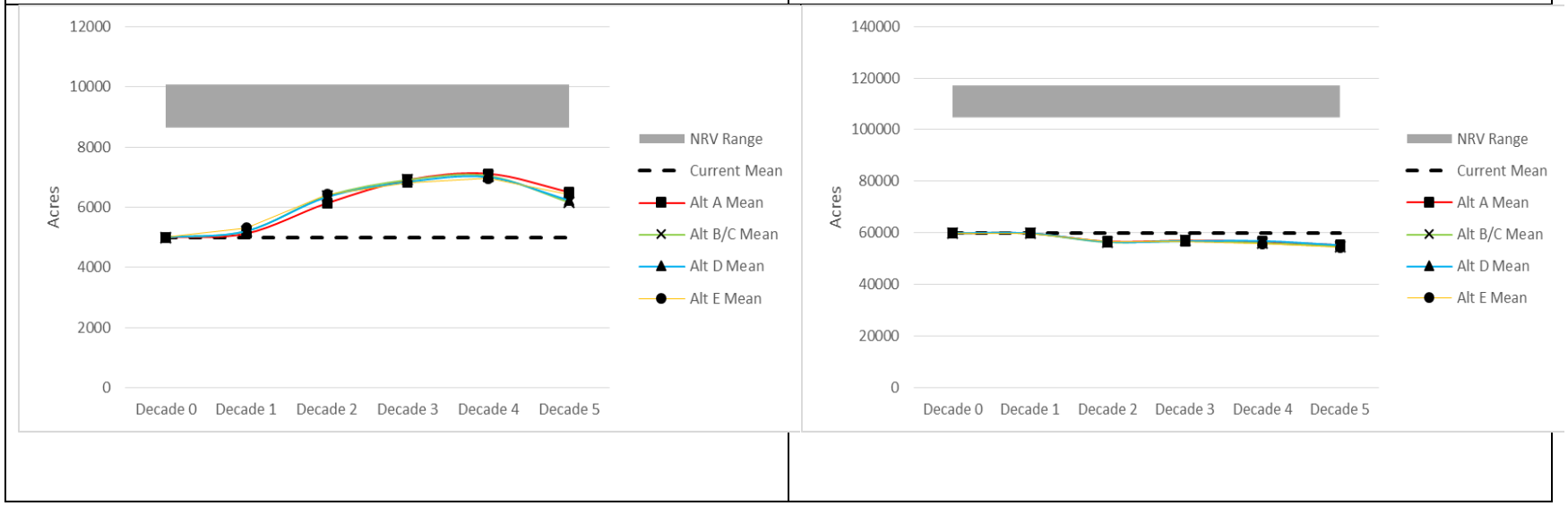


Figure 146. Elk winter habitat by GA over time by alternative – Snowies and Upper Blackfoot GAs



Recreation Settings, Opportunities, Special Uses, and Access

The analysis for sustainable recreation settings used existing travel plan information and the geographic information system to map each of the recreation opportunity spectrum classes. These classes were verified with forest personnel familiar with these areas.

Data for the recreation opportunities, recreation special uses, and recreation access portion of this analysis were derived from the Forest Service corporate database, Infrastructure. This database houses the specific information about the numbers, quantities, and types of recreation opportunities and special uses as well as the miles and status of roads and trails. This data was verified by forest personnel prior to inclusion in this analysis.

Scenery

The FS uses the scenery management system to inventory, analyze, and monitor national forest scenic resources. This system recognizes natural disturbance processes such as fire, insects, and disease to be part of the natural landscape that is dynamic and also important in maintaining healthy, sustainable, and scenic landscapes. The scenery management system is also used in the context of ecosystem management to determine the relative value, stability, resiliency, and importance of scenery; assist in establishing overall resource objectives; and ensure high-quality scenery for future generations. The primary components of the scenery management system are:

- scenic character,
- scenic attractiveness,
- landscape visibility,
- existing scenic integrity,
- scenic classes, and
- scenic integrity objectives

The Forest completed an inventory of landscape visibility and scenic attractiveness, and compiled scenic classes. In 2011, the FS's Northern Region completed existing scenic integrity mapping at a regional scale. Using this data, scenery was analyzed on a forestwide scale and included the encompassing viewsheds of the HLC NFS lands and the surrounding nonforest system lands. Landscape character descriptions for each of the GAs have been developed and are located in appendix J of the Draft Plan.

Data used to conduct the analysis came from the latest spatial information contained in the geographic information system data. Acreages and percentages of scenic integrity objectives were analyzed to determine how well they support the inherent scenic character and move the landscape toward desired scenic integrity objectives.

Administratively Designated Areas

The analysis for the existing administratively designated areas used maps stored in the National Forest's GIS. Existing GIS maps were available for the following areas and were used in this analysis:

- Inventoried Roadless Areas
- National Recreation Trails
- Research Natural Areas
- Tenderfoot Creek Experimental Forest
- Elkhorns Wildlife Management Unit
- Kings Hill Scenic Byway

In addition to these existing administratively designated areas, the HLC NF identified the following 4 new areas on the forest that may be administratively designated in the revised Forest Plan. The boundaries for these areas were identified and mapped for this analysis.

- South Hills Recreation Area
- Missouri River Corridor
- Smith River Corridor
- Badger Two Medicine Area

Congressionally Designated Areas

The analysis for designated areas used the official maps from the enabling legislation for these lands which are stored in the geographic information system. The HLC NF used the enabling legislation and official designated areas maps to analyze the following areas:

- Designated wilderness areas
- Wilderness study areas
- Continental Divide National Scenic Trail
- Lewis and Clark National Historic Trail
- Lewis and Clark National Historic Trail Interpretive Center
- Rocky Mountain Front Conservation Management Areas

In addition to congressionally designated areas, the HLC NF was required to conduct both a wilderness evaluation and an eligible wild and scenic river study as a part of the forest planning process. The following information outlines the methodology utilized for those two processes.

Wilderness Evaluation

The analysis for identifying potential recommended wilderness areas used official maps stored in the geographic information system. Specific data used to assess potential wilderness characteristics and overall descriptions were derived from the FS corporate Infrastructure database. This database houses the specific information about the acres, miles of trail, and facilities available within each wilderness area. Data was verified by forest personnel prior to inclusion in this analysis.

The geographic scope of the analysis included all lands administered by the Forest within the planning area. All lands within the HLC NF boundary form the geographic scope for cumulative effects, and the temporal scope was the life of the plan (approximately 15 years).

The process by which lands are recommended for inclusion in the National Wilderness Preservation System was intended to be transparent and consistent across the NFS. To accomplish this, the process occurred in four primary steps (2012 Forest Service Planning Rule and Chapter 70 of the FS Land Management Planning Handbook 1909.12.) Each step of the process required public participation and collaboration, intergovernmental coordination with state and local governments, and tribal consultation (as required by the broader planning process). Steps 1-3 have been accomplished. Step 4 will be completed with the signing of the Record of Decision when the FEIS process has been completed.

1. Inventory: The Responsible Official (the Forest Supervisor) identifies and creates an inventory of all lands that may be suitable for inclusion in the National Wilderness Preservation System.
2. Evaluation: The Responsible Official evaluates the wilderness characteristics of lands identified in the inventory using a set of criteria based on the Wilderness Act of 1964.

3. Analysis: The Responsible Official considers the areas evaluated and determined which areas to further analyze for recommendation as part of one or more alternatives identified in a NEPA document.
4. Recommendation: The Responsible Official decides, based upon the analysis and input from Tribal, State, and local governments and the public, which areas, if any, to recommend for inclusion in the National Wilderness Preservation System.

All plan revisions are required to complete this process before the responsible official determines, within the plan decision document, whether or not to recommend lands within the plan area to Congress for wilderness designation. Wilderness recommendations are only preliminary administrative recommendations; Congress has reserved the authority to make final decisions on wilderness designation.

Wilderness characteristics are based on natural quality, undeveloped area, unconfined or primitive recreation or solitude, and unique or other features. Oftentimes, the ecological characteristics are discussed in terms of natural quality and undeveloped and can be represented by landscapes where the ecosystems of the area are intact and/or evidence of human disturbance is not readily apparent. Social characteristics can be discussed in terms of solitude or unconfined or primitive recreation and are often represented by remote, quite landscapes where recreation activities such as hiking, climbing, fishing and hunting are predominant.

The HLC NF conducted a wilderness evaluation process outlined in the 2012 FS Planning Rule, Chapter 70 (Forest Service Land Management Planning Handbook 1909.12). Additional lands with potential for inclusion in the National Wilderness Preservation System were identified and evaluated in this process.

The inventory and evaluation steps were completed and displayed as an appendix in the proposed action. This draft environmental impact statement describes the analysis step. The recommendation step will result from the final environmental impact statement and will be recorded in the record of decision. Recommendations of potential wilderness areas are only preliminary administrative recommendations. Congress reserves the authority make final decisions on wilderness designation. The ecological and social characteristics of recommended wilderness areas that provide the basis for suitability for inclusion into the National Wilderness Preservation System are identified for each recommended wilderness area by alternative and can be found in appendix E of the DEIS.

Eligible Wild and Scenic Rivers Study

The 2012 Planning Rule's Final Directives (FSH 1909.12 Chapter 80) provided guidance for conducting a wild and scenic rivers eligibility study during forest plan revision. The HLC NFs used this guidance to conduct the wild and scenic rivers eligibility study for the planning area using the following steps.

Step 1: Identified free-flowing named streams/rivers.

Step 2: Identified regions of comparison for each resource.

Step 3: Developed evaluation criteria for identifying outstanding remarkable values.

Step 4: Evaluated named streams/rivers and determine if they possess outstanding remarkable values.

Step 5: Reviewed level of development/determined classification of wild, scenic, or recreational.

Step 6: Developed forest plan management direction (included in the proposed action).

The eligibility study was conducted through a series of meetings and workshops aimed at each of the steps identified in the process paper. Much of the base information was developed from GIS, such as the

base maps, determining the number and location of all “named streams”, and identifying the location of developments along or nearby these rivers and streams. Specific resource information about each river/stream was gathered from maps and professional knowledge provided by forest resource specialists.

The geographic scope of the wild and scenic rivers eligibility study was the free flowing rivers and streams located within lands administered by the Forest. Rivers and segments of rivers that pass through private lands were not considered in the eligibility study. All lands within the HLC NF boundary form the geographic scope for cumulative effects, and the temporal scope is the life of the plan (15 years).

The document that summarizes the wild and scenic rivers eligibility study, as well as, descriptions of each eligible river and maps is located in appendix G of the Draft Plan.

Cultural, Historical, and Tribal Resources

The Regional Programmatic Agreement and the forest-specific Site Identification Strategy address details of National Historic Preservation Act/Sec. 106 compliance. They prescribe certain percentages of survey coverage for various types of undertakings, in order to adequately complete Sec. 106 effects analysis. The amount of survey and research anticipated depends on the undertakings involved. Information from project-level analyses assigns the ‘potential for the occurrence of cultural resources’ used in both NEPA and National Historic Preservation Act reviews.

The primary goal of a cultural resource inventory is to locate and describe archaeological, historic and cultural sites and to make a recommendation of significance when such sites are found. Significance evaluations of known cultural resources and new sites discovered during inventories of a project area would follow general guidelines as set forth below:

1. Cultural materials were observed in depositional or surficial settings where cultural remains may have been buried or disturbed in essentially their original positions, thus preserving spatial context.
2. Artifacts diagnostic of historic or prehistoric cultural periods were found. Presence of such artifacts allows dating of cultural components and establishment of temporal and cultural context.
3. Presence of diagnostic artifacts in potentially preserved context makes it possible for a site to contribute significantly to understanding of local and regional history and prehistory.
4. Historic sites were found to associate with the lives of person(s) significant to local or regional history. Such associations can be apparent through archival research.
5. Historic or prehistoric sites were found to contain well-preserved features such as buildings, roads, trails, tipi rings, cairns, effigies, pictographs, or petroglyphs. Such features may be representative of or associated with an important period, architectural style, artistic style, or a unique or specialized activity.
6. Physical evidence of past or present cultural use of a locality for prayer, fasting, vision questing, piercing, burial, and other ceremonial activities were found. That evidence could include prayer cloth, rock structures, marked trees, sweat lodge remnants or hearths, or other lodge remnants. Presence of these things allow for identification of Traditional Cultural Properties.

Information from historic maps, the heritage resource database, and from numerous surveys completed in previous project areas identifies specific locations of prehistoric and historic sites. This information provides historic context and helps identify both specific sites present and the kind of sites which may exist across the Forest.

Evaluation of all potential historic properties, including traditional cultural properties, follows a set of criteria established by the Montana State Historic Preservation Office and the National Park Service. Historic properties are determined to be significant if they meet one or more of the following criteria (USDI-NPS Bulletin 15):

a. They are associated with events that have made a significant contribution to the broad patterns in our history; and/or
b. They are associated with the lives of persons significant in our past;
c. They embody distinctive characteristics of a type, period, or method of construction that represents the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction;
d. They have yielded, or may likely yield, information important in prehistory or history.

If sites do not meet the criteria for eligibility for the National Register of Historic Places after consultation with the appropriate parties, Section 106 of the National Historic Preservation Act stipulates no further consideration of cultural resources is necessary and the undertaking may proceed.

If a site meets any of these criteria, Section 106 requires an agency to determine the effect of the proposed action on the site. One of the following three determinations is possible:

1. No historic properties affected – a Heritage Specialist has determined that either there are no historic properties present or there are historic properties present, but the undertaking will have no effect upon them. The agency will notify all consulting parties and make the documentation available for public inspection before approving the undertaking.
2. Historic properties affected – a Heritage Specialist finds that there are historic properties the undertaking may affect or the State Historic Preservation Office/Tribal Historic Preservation Office or the Advisory Council objects to the agency's findings. The agency then will notify all consulting parties, invite their views on the effects, and assess adverse effects, if any.
3. Adverse effect – the Heritage Specialist determines that the effect on eligible cultural resources will be adverse. When an undertaking has been determined to have an adverse effect on a property eligible for listing, the agency is directed to consult with the State Historic Preservation Office/Tribal Historic Preservation Office and other consulting parties to develop and evaluate alternatives or modifications to the undertaking that could avoid, minimize or mitigate adverse effects on historic properties. Mitigation of effects to a significant cultural resource entails a range of options including project redesign, avoidance, documentation (photography and archival research), or restoration and data recovery (through archaeological excavation). Mitigation options are selected on a case-by-case review and are tailored to the distinct values of the property and the planning options available within the project design. Once the agency and the State Historic Preservation Office agree on the mitigation measures for eligible properties and the conditions or stipulations have been met, the project may proceed.

The FS relies on its relationship and consultation with tribes to identify areas of tribal importance that may be impacted by FS actions. The consultation process affords both Tribes and the FS opportunities to identify sites, interests, and values of tribal importance as well as to design protective measures that avoid or mitigate effects to cultural or historical resources that are important to tribes.

Land use management plans, heritage reports, survey and research information, information from FS heritage resource specialists, and consultation with Tribe members are the primary sources of information used for this analysis.

Lands

The total acres of NFS lands are derived using a GIS measuring process. The total is comprised of lands under FS jurisdiction both within and outside of the proclaimed NFS boundary. The total acres of non-NFS lands are provided by the Washington Office Lands group and are only those lands within the proclaimed NFS boundary. The data source for the number of special use authorizations is the national special uses data system.

The FS uses the Land Status Record System (LSRS) as the repository for realty records and land title documents. The LSRS includes accurate information on ownership acreages, condition of title, administrative jurisdiction, rights held by the United States, administrative and legal use restrictions, encumbrances, and access rights on land or interests in land in the NFS.

The FS uses the Special Uses Data System (SUDS) to create and administer special use authorizations. The data in SUDS is supported by hard copy files at Ranger District and Forest Supervisor's offices.

The FS uses the Title Claims and Encroachments Program to store data related to encroachments. This program provides a consistent, standard, operating method to inventory, process and resolve title claims and encroachment cases, and sort the data needed to prepare summary reports for management. The primary focus of Title Claims and Encroachments Program is the defense and protection of the lands and title of the public's estate managed by the FS.

Infrastructure

Information used to conduct the analysis generally comes from the national Infrastructure database. This database is a collection of web-based data entry forms, reporting tools, and mapping tools (GIS) that enables forest staff to manage and report accurate information about their inventory of constructed features and land units.

Social and Economics

Scale

The spatial scale for the analysis was determined as part of the Assessment process. Several factors were taken into account including FS staff expertise, commuting patterns, recreational visitation, trade, travel corridors, social and cultural identity and timber processing areas. The temporal scope is the life of the plan (15 years). For a complete discussion of the process for determining the analysis area, please see the Helena-Lewis and Clark Assessment (Ch 5, p2), as well as the USDA Forest Service Protocols for Delineation of Economic Impact Analysis Areas (METI, 2010).

Analysis

Economic and social benefits of the Forest are measured by identifying how ecosystem services (including multiple uses), infrastructure and operations, either directly or indirectly, contribute to economic and social sustainability. Specifically, ecosystem services are those societal benefits the Forest provides, including both goods and services, that are of value to people. Infrastructure and operations benefits include both physical elements, such as roads and facilities, as well as all the services the Forest staff provide such as fire suppression and educational programs.

The FS manages NFS lands according to the principle of multiple use. This principle allows the agency to manage land for a variety of uses, including amenity, commodity, non-commodity, and recreation. The Multiple-Use Sustained-Yield Act (P.L. 104–333) formalized this management philosophy, stating that the FS is to manage resources to best meet the needs of the American public, with flexibility to provide

for “periodic adjustments in use to conform to changing needs and conditions” (Section 4(a) of the Act [16 U.S.C. 531]). For instance, areas suitable for timber production may contribute to the local economy by sustaining timber sector jobs and income; thereby maintaining social fabric and lifestyles of the community. Wilderness areas generate significant social well-being by providing world-class recreational settings and inspiration. Visitors from near and far may benefit from experiencing solitude in these pristine locations while contributing to the regional economy (i.e. travel and tourism related sectors) in terms of jobs, income and other economic activities.

Numerous approaches exist for measuring society’s condition or progress towards achieving social and economic sustainability. In the forest planning context, a broad ecosystem services framework, which catalogues societal benefits of forests, is an ideal framework for identifying how the plan area contributes to social and economic sustainability.

Societal benefits of the Forest are used and/or valued differently by different groups and communities. The Assessment provided a brief overview of social and economic conditions and highlighted the benefits the Forest provides to the affected communities. In the Affected Environment section, the social and economic conditions of affected communities are summarized alongside a discussion of the key societal benefits the Forest provides to beneficiaries.

Livestock Grazing

The analysis area includes NFS rangelands within grazing allotments across the entire HLC NF plan area. While the HLC NF has recently been combined into one administrative unit, the existing forest plan guidance and much of the available data is split by the old forest boundaries. Therefore, the units are described separately where appropriate in the analysis. A portion of the Beaverhead-Deerlodge National Forest in the Elkhorns GA is managed by the HLC NF as well.

The proposed action and alternatives to the proposed action include components that describe actions that may, or may not, impact the management of grazing livestock. For this analysis, each alternative is evaluated using one or more key indicators to determine the overall impacts to livestock grazing on NFS land. When the degree of impact cannot be quantified, a qualitative assessment is used based on professional judgment and, when possible, in conjunction with available data.

Timber and Other Forest Products

Alternatives B and C are identical in terms of vegetation and timber components, and other elements that influence timber production and harvest. Therefore, they are analyzed together as alternatives B/C.

Analysis area

The analysis area for timber suitability, supply, harvest, and other forest products is comprised of the NFS lands administered by the HLC NF. The analysis area for timber demand consists of sixteen counties that contain infrastructure and/or communities that utilize timber from the HLC NF, as shown in Table 10.

Table 10. Counties affected by HLC NF timber outputs

County group	Counties
North	Glacier, Pondera, Teton
Central	Cascade, Choteau
East	Fergus, Judith Basin, Meagher, Wheatland
West	Broadwater, Jefferson, Lewis and Clark, Powell
Secondary	Deer Lodge, Gallatin, Park

Identification of Lands Suitable for Timber Production

The National Forest Management Act ("National Forest Management Act of 1976," 1976) directs that, "*the Secretary shall identify lands within the management area which are not suited for timber production, considering physical, economic, and other pertinent factors to the extent feasible*." The 2012 planning rule directives (USDA, 2015) provide detailed guidance regarding the identification of lands as not suited and suited for timber production. Per this direction, lands suitable for timber production have been identified for each alternative using the methodologies described in this section; maps are included in appendix A. During plan implementation, site-specific suitability must be determined at the project level.

Harvest of timber on NFS lands occurs for many reasons, including but not limited to habitat or ecosystem restoration, community protection, protection of municipal water supplies, and contribution to economic sustainability through providing timber products and fuel as renewable energy. *Timber harvest* is the removal of trees for wood fiber use and other multiple-use purposes. In contrast, *timber production* is the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (U.S. Department of Agriculture, Forest Service, 2012).

The identification of lands suitable for timber production was accomplished using GIS. Lands that are unsuitable for timber production, but where timber harvest may occur to meet other objectives, were also mapped. Criteria for determining lands not suitable for timber production are assessed with two-steps:

5. Identify lands that are not suited for timber production based on legal and technical factors. These lands do not vary by alternative and are identified in the assessment or prior to development of alternatives. This is a preliminary classification. The factors to be used to identify lands at this stage are:

(i) Statute, executive order, or regulation prohibits timber harvest on the land;

(ii) The Secretary of Agriculture or the Chief of the FS has withdrawn the land from timber production;

(iv) The technology is not currently available for conducting timber harvest without causing irreversible damage to soil, slope, or other watershed conditions;

(v) There is no reasonable assurance that such lands can be adequately restocked within 5 years after final regeneration harvest; or

(vi) The land is not forest land.

After subtracting the lands that are not suited from the total of national forest system lands, the remaining lands are lands that *may be suited for timber production*, and are considered in step 2.

6. From the lands that may be suited for timber production, identify the lands that are suited for timber production based on their compatibility with the land area's desired conditions and objectives for those lands. This is done for each alternative considered. The factor used to identify lands at this stage is:

(iii) Timber production would not be compatible with the achievement of desired conditions and objectives established by the plan.

Lands that may be suitable for timber production

Table 11 lists the technical factors and definitions used to identify that lands that are not suited for timber production. These lands were subtracted from the total NFS land acreage, and the remaining areas are those that *may be suited for timber production*. This preliminary classification as described above. The determination of lands that may be suited for timber production provides the first step and basis for determining the lands that are suited for timber production, and it is the landbase used to calculate the sustained yield limit.

Table 11. Criteria for the Identification of lands that may be suited for timber production

Technical Factor (36 CFR 219.11(a))	Definition and Description FSH 1909.61.1 (USDA, 2015)
(i) Statute, Executive Order, or Regulation prohibits timber production; or (ii) The Secretary of Agriculture or Chief of the Forest Service has withdrawn the land from timber production.	Timber production may be prohibited on certain lands by statute, Executive order, regulation, or where the Secretary of Agriculture or Chief of the Forest Service has withdrawn the land from timber production. Examples include wilderness, eligible and/or designated wild river segments, research natural areas, and other designated areas where timber production is specifically prohibited.
(iv) The technology is not currently available for conducting harvest without causing irreversible damage to soil, slope, or other watershed conditions.	Lands not suited because technology to harvest timber without causing irreversible damage is not currently available may include areas where soils, geology, or other physical site conditions are such that harvest may cause irreversible damage, or where tree regeneration and growth is severely inhibited; for example, shallow or excessively wet soils; excessively steep slopes; avalanche areas; and floodplains. Criteria should take into account information such as landforms, soil conditions, vegetation, and available technology for harvest. Information may be used to assess soil vulnerability to physical, chemical, and biological damage.
(v) There is no reasonable assurance that such lands can be adequately restocked within 5 years after regeneration harvest.	The Responsible Official should identify criteria for what constitutes adequate restocking after final regeneration harvests for timber production. Specific land types, soil types, and vegetative conditions should be evaluated for appropriate management systems to assess if reasonable assurance exists that the lands can be regenerated to achieve adequate restocking 5 years after final regeneration harvest. Consider relevant information such as soil maps, geological maps, monitoring, and other best available scientific information.
(vi) The land is not forest land	Lands less than 10% occupied by trees of any size or that formerly had tree cover but are developed for nonforest uses (such as agriculture, pasture, residential areas, improved roads, recreation areas, and powerlines). Lands that were formerly occupied by tree cover, but do not have tree cover, should be identified as nonforest unless the land will be naturally or artificially regenerated in the near future. Canopy cover of live trees at maturity may be used to estimate if an area is at least 10 percent occupied. Unimproved roads, trails, intermittent or small perennial streams, and clearings may be included as forest if < 120' wide.

A spatial analysis was conducted that methodically subtracted unsuitable lands from the total land area based on legal or technical factors, as shown in Table 12. The areas were eliminated in the order shown; therefore, factors that were eliminated first may encompass conditions that would have been eliminated in later steps. For example, relatively few acres were eliminated for soil or stability concerns; this is because some of these areas were already eliminated through the exclusion of wilderness, inventoried roadless areas, and nonforest lifeforms. Due to the resolution of data sources, there will be inclusions of suitable lands in unsuitable areas and vice versa; thus it is important to validate suitability at the project level.

Table 12. Areas eliminated from lands that may be suitable for timber production

Factor	Areas Eliminated	Approximate Acres
	Total NFS lands	2,883,339
36 CFR 219.11(a) (i) and (ii)	Designated wilderness	564,562
	Designated wild & scenic rivers	0
	Rocky Mountain Front Conservation Management Areas	195,653

Factor	Areas Eliminated	Approximate Acres
	Wilderness Study Act areas	161,688
	Research Natural Areas	11,848
	Tenderfoot Experimental Forest	7,671
	Inventoried Roadless Areas	1,017,320
	Total acres eliminated for this factor	1,958,854
36 CFR 219.11(a) (vi)	Administrative sites & campgrounds[1]	278
	Roads, railroads, and utility corridors[2]	19,800
	Water bodies and streams >120' wide	927
	Nonforest lifeforms[3]	148,363
	Total acres eliminated for this factor	169,368
36 CFR 219.11(a) (iv) and (v)	Areas with soil stability or damage concerns[4]	15,155
	Areas with low growth/regeneration potential[5]	72,956
	Total acres eliminated for this factor	88,111
	Lands that may be suitable for timber production	667,119

1 The latest administrative site and campground layers were utilized, applying a 200' buffer.

2 All roads not planned for decommissioning are assumed to be "improved". Line files provided by Northwestern Energy were used. A 33' width buffer was applied to roads, corridors, and railroads.

3 Nonforest lifeforms were depicted by VMap classes of water, sparse, herb, shrub, or urban; or Ecoclass of Scree; unless recent fires or harvest had occurred and the potential vegetation type was forested.

4 Areas with average slopes >80%; severe slump/mass failure risk; or with percent slope >50% and bedrock type of slide deposits.

5 Areas with a potential vegetation type of sparse, limber pine, whitebark pine, subalpine larch, juniper, alpine, poplar/aspen, or ripdecid; or a tree growth composite index of 5 or 6 unless recently disturbed; or a tree growth composite index of 4 and dominated by juniper, whitebark pine, limber pine, or tree canopy <10% unless recently disturbed. These areas were also reviewed and modified with input from local resource specialists.

Lands that are suitable for timber production, by alternative

The identification of lands that are suitable for timber production in each alternative is based on compatibility with desired conditions and objectives (USDA, 2015), and are a subset of the lands that may be suited. These lands are identified based on the desired conditions, goals, and objectives developed for the draft plan and for each alternative.

Table 13. Criteria for the Identification of lands that are suited for timber production

Factor	Definition FSH 1909.61.2
36 CFR 219.11(a) (iii) Timber production would not be compatible with the achievement of desired conditions and objectives established by the plan	The Responsible Official should consider the following to determine if timber production is compatible with the desired conditions and objectives of the plan: Timber production is a desired primary or secondary use of the land; Timber production is anticipated to continue after desired conditions have been achieved; A flow of timber can be planned and scheduled on a reasonably predictable basis; Regeneration of the stand is intended; Timber production is compatible with the desired conditions or objectives for the land designed to fulfill the requirements of 36 CFR 219.9 to 219.10.

Lands suitable for timber production were mapped for the initial proposed action, which was made available for public scoping. Timber harvest, volume outputs, and lands suitable for timber production were identified as a key or significant issue based on the public comments received. Therefore, it was one element that drove the development of alternatives, as described in Table 14.

Table 14. Considerations for determining lands suitable for timber production, by alternative

Alternative	Considerations and Rationale
Alternative A, No Action	Alternative A, No Action, represents the current forest plans as amended and implemented. Suitability for timber production was mapped by starting with suitability as defined in the 1986 plans, and then updated to reflect the changes that have occurred since then that would continue to drive management into the future. The primary change incorporated was the removal of suitability where inventoried roadless areas were established. It was also updated to be consistent with the new may be suited layer in terms of the technical factors, because it is based on new data.
Alternative B, Proposed Action	Alternative B is the proposed action. Lands suitable for timber production was initially mapped prior to public scoping. The areas that were subtracted from the may be suited acreage because timber suitability was not compatible with plan objectives included the Elkhorns GA, the Highwoods GA, the Snowies GA, the Badger-Two Medicine area, the Dry Range, the South Hills Recreation Area, the Tenderfoot land acquisition area, and the Missouri River Corridor. Lands that overlapped with recommended wilderness was also dropped. Other cultural or historical sites were removed, including the Alice Creek Historic District, the Chinese/Robertson wall, the Smith River corridor, the Mann Gulch Historic District, and the Lincoln Gulch Historic District. Updates were made to campground and utility corridor buffers based on new available data. The modified proposed action for the DEIS was further updated to eliminate areas with a Recreation Opportunity Spectrum (ROS) class of Semi-Primitive Non-Motorized, where timber production would be precluded due to poor access, low feasibility, and ROS objectives. In addition, eligible wild and scenic river corridors were excluded.
Alternative C	The lands suitable for timber production are identical to Alternative B.
Alternative D	Alternative D was mapped starting with the suitability layer for Alternatives B/C, and further reducing lands suitable for timber production where they overlapped with the additional recommended wilderness, semi-primitive non-motorized, and primitive ROS areas.
Alternative E	For Alternative E, the may be suited layer was included to the greatest extent. Compared to Alternative B/C, the only landscape areas excluded are the Badger Two Medicine and Elkhorns GA, along with special cultural or historical sites. ROS classifications were adjusted to be compatible with timber harvest where possible (roaded natural or rural). There are no recommended wilderness areas, so lands that were excluded in these areas in other alternatives were added back in. The South Hills Recreation area is not included in this alternative, and therefore the lands that may be suited within this area were included as suitable for timber production.

Riparian management zones are also not suitable for timber production. For the DEIS, these areas are unsuitable inclusions where they occur within lands suitable for timber production, because mapping was not readily available to identify them. The DEIS discusses the potential influence and magnitude of the management restrictions within these areas relative to timber production and harvest.

In addition, eligible wild and scenic rivers were identified for the action alternatives (B, C, D, and E). These corridors are excluded from the final timber suitability maps and acreages, as described in the table. However, these areas were not excluded in the mapping that was used for the timber modeling with Spectrum. This resulted in roughly 456 acres being incorrectly included in the modeling for alternatives B/C and E, and 284 acres in alternative D; these overlaps occurred in the Little Belts GA. This acreage is negligible (representing less than 0.06% of the Little Belts GA) and would not materially affect the timber modeling and other conclusions reached with this programmatic analysis. The acres of suitability as mapped and reported in the DEIS correctly exclude the wild and scenic river corridors.

Spectrum Model Design

Spectrum is a software modeling system designed to assist decision makers in evaluating resource management choices and objectives. Models constructed with Spectrum apply management actions to landscapes through a time horizon and display outcomes. Management actions are selected by the model to achieve desired goals (objectives) while complying with management objectives and limitations (constraints). Spectrum makes it possible to display management actions to landscapes at multiple spatial and temporal scales. It is effective for modeling alternative resource management scenarios in support of strategic and tactical planning. Examples of this include scheduling vegetation treatments to achieve desired conditions; modeling resource effects and interactions within management scenarios; and exploring "tradeoffs" between alternative management scenarios.

Spectrum was used to model potential vegetation treatments and outcomes across the HLC NF over time under each alternative. The alternatives were modeled with an objective based on achievement of desired conditions for forest composition and size classes. For example, a downward trend in the small size class and upward trend in the large size class are desired conditions, which the model may achieve with regeneration treatments, commercial thinning, and retaining stands to advance into larger tree size classes. Alternative E was also modeled with an objective of achieving 95% of the maximum possible timber output based on the theme of that alternative.

The model applies constraints based on factors that would limit potential treatments, such as lynx habitat, operational or logistical limitations, and management regimes (such as suitability for timber production and recreation opportunity spectrum settings). Limits associated with expected budget levels are also evaluated. Spectrum model formulation and outcomes provide a schedule of activities for the HLC NF that help provide answers to the following questions:

- What vegetative treatments are selected and how should they be scheduled to move towards the desired conditions for vegetation, with and without budget limitations?
- What is the projected timber sale quantity and projected wood sale quantity, with and without budget limitations?
- What amount of timber can be removed annually in perpetuity on a sustained-yield basis (i.e., the sustained yield limit)?

The key variables and assumptions used for Spectrum modeling are summarized in this section. Please see the report *Helena and Lewis & Clark National Forests Plan Revision: Construction of Vegetative Yield Profiles & SPECTRUM Model Design*, for detailed information. The assumptions used are designed to best approximate probable future management scenarios that are consistent with forest plan direction; these assumptions are not binding management constraints for implementation of the plan. For example:

- Treatment prescriptions represent commonly used activities and schedules based on vegetation types, but actual site-specific prescriptions would be specifically tailored to each site.
- The budget constraint is based on recent and reasonably foreseeable budget levels, but actual budgets may vary and so too would the amount of vegetation management that occurs.
- Project costs as well as timber values are estimated using the best available information, but these could change in the future.
- Expected disturbance levels were applied to best approximate future vegetation conditions, but there is a high level of uncertainty in the timing and location of future disturbance events.
- Resource-based constraints such as dispersion of openings, the proportion of treatment types in various land allocations, and lynx habitat requirements are applied broadly, but project design and analysis may apply such considerations differently based on a site specific analysis that follows the most current law, regulation, and policy at the time of implementation.

- The desired conditions that can be specified for the model are limited in number and complexity. Implementation of the plan would consider many additional desired conditions, which may result in a treatment regime that differs relative to the type and timing of vegetation treatments as well as the vegetation types that are treated.

The projected timber volumes, harvest acres, and prescribed burning acres depict possible management scenarios to provide for a comparison of alternatives. The model results also form the basis of the potential management actions described in appendix C of the Draft Plan, and inform the objectives for vegetation treatments in the Draft Plan. They are not precise targets, and actual implementation of the plan may vary based on the factors described above as well as other considerations such as litigation.

Planning horizon

The planning horizon is a specified time frame broken down into periods of an equal number of years. The HLC NF Spectrum model used 15 ten-year periods as the planning horizon. A long planning horizon helps ensure the sustainability of management options applied to long-lived vegetation. The results are shown for the first 50 years because results become more and more uncertain farther out into the future.

Yield tables – Forest Vegetation Simulator

Growth and yield tables were developed using the Forest Vegetation Simulator, which is a family of forest growth simulation models. Since its initial development in 1973, it has become a system of highly integrated analytical tools. These tools are based upon a body of scientific knowledge developed from decades of natural resources research. Available data from FIA base and intensified grid plots was stratified according to vegetation type and structure, and the Forest Vegetation Simulator was run to estimate key variables throughout the life of the plot under several possible management scenarios. Spectrum uses yield table information to select management options to move towards the desired condition, and to show the outcomes of the harvest schedule over time. Yield tables included the following outputs:

- Stand age, basal area, diameter, trees per acre, and culmination of mean annual increment
- Merchantable cubic feet board feet, harvested and remaining on the site
- Diameter of removals and residual volume
- Fire risk
- Snags per acre and presence
- Bark beetle risk and defoliator risk
- Large trees per acre and presence
- Carbon total tons
- Tons/acre downed woody material
- Vegetation type and structure class
- Presence and composition of key tree species (ponderosa pine, whitebark pine, whitebark pine, aspen, western larch, and limber pine)

Land stratification and analysis units

The planning area is subdivided into areas that facilitate analyzing land allocation and expected management. In Spectrum, each stratum is a layer and a unique combination of layers results in an "analysis unit." The HLC NF used five layers of information to develop analysis units. The combination of classes in each layer creates a repeatable land unit with unique characteristics. The land stratification layers identified for each alternative are all of the unique combinations of the following five layers:

- Geographic area and wildland urban interface (Upper Blackfoot GA or island mountain ranges, and wildland urban interface delineations)
- Management area group (combinations of suitable or unsuitable for timber production; whether harvest is allowed in unsuitable lands; and recreation opportunity spectrum setting)
- Wildlife condition (lynx and/or grizzly bear habitat)
- Vegetation type (potential vegetation type and existing vegetation composition)
- Vegetation structure (size class and density class)

Only forested vegetation types were included in the Spectrum modeling; therefore, the total acres modeled are less than the HLC NF as a whole, and results do not represent treatments such as prescribed fire which could occur on nonforested vegetation types.

Management actions and timing

Management actions consist of activities associated with a generalized silvicultural prescription. The prescriptions, timing choices, and constraints are for modeling purposes and do not constitute standards or guidelines for implementation. Silvicultural prescriptions were defined by vegetation type, structure, and other resource conditions. Table 15 describes the prescriptions that were developed. The detailed prescriptions can be found in the planning record.

Table 15. Prescriptions and management activities used in spectrum

Prescription	Possible Activities
Natural growth	None
Stand Replacing Wildfire	Wildfire
Mixed Severity Wildfire	Wildfire
Severe Bark Beetle	Severe bark beetle
Natural Attrition	None
Clearcut/Seedtree	Precommercial thin, commercial thin, understory burn, broadcast burn, seed cut, overstory removal, regeneration
Shelterwood	Precommercial thin, commercial thin, understory burn, broadcast burn, seed cut, overstory removal, regeneration
Uneven-aged Cut	Group selection opening, single tree selection, Precommercial thin, commercial thin, understory burn, broadcast burn, regeneration
Prescribed Burn	Understory burn, broadcast burn

Several timing choices were applied to the prescriptions. Timing choices specify the range of ages in which a stand may be treated. The earliest point at which a stand could be regeneration harvested was based on culmination of mean annual increment. Based on constraints and the specified management goals or objectives, the Spectrum model determines the management prescription to apply to an analysis area as well as the timing of the implementation.

Costs for management activities

Costs were developed for the following management activities, and applied to prescriptions selected by Spectrum. All costs are part of the budget constraint, and are taken into account when the model schedules treatment activities.

- Timber planning (analysis, sale prep, and administration), applied based on volume harvested
- Reforestation, applied on a per acre basis

- Timber stand improvement, applied on a per acre basis
- Road re-construction and administration, applied on a miles per acre treated basis
- Prescribed burning, applied on a per acre basis
- Weed treatments, applied on a per acre basis
- Treating heavy downed fuels, applied on a per acre basis for the first three decades (in response to beetle-killed stand conditions)
- Treatments in whitebark pine, applied on a per acre basis

Timber values

Stumpage values for timber were developed with a residual value calculation, meaning that stumpage value is the difference between the delivered log price at a mill and the estimated harvest and delivery costs incurred by a buyer who purchases the timber. Forest product values were developed by species group, which were cross walked to Spectrum cover type strata. The following assumptions were used:

- Prices reflect a Regional analysis of 10-year average stumpage prices by species, subtracting logging and hauling costs, and adjusting for inflation to 2015 dollars.
- Values were based on proportions of tractor, cable, cut-to-length, and helicopter logging systems reflecting the typical mix on the HLC NF.
- Typically ponderosa pine “sawlogs” are sold as “nonsaw”.
- Nonsaw material is cut and removed as a product. This material adds approximately 15% more volume to all types. Volume estimates are adjusted accordingly to calculate the PWSQ. PTSQ is based solely on sawlog volumes.
- An additional 1.35 mmcf of volume was added to PWSQ to represent the firewood program.

Management constraints

Management constraints are limits defined to model resource thresholds, relations between and among activities and outputs, policy requirements, or monetary limitations. The following constraints that were incorporated into the Spectrum model in response to Forest Plan direction, regulations, and as a means of improving the model's ability to simulate actual management. Constraints were for modeling purposes only and do not create limitations for Plan implementation.

- Budget constraint is based on a 3-year average of actual budgets for 2013, 2014, and 2015, including a break out of funds required to be spent in the wildland urban interface. Outputs are shown with and without the budget constraint.
- Harvest policy is to achieve non-declining yield and long term sustained yield. Non-declining even flow is applied to each congressionally designated national forest separately (the Helena and Lewis and Clark respectively) for the sustained yield limit run. Non-declining even flow is not required for the projected timber and wood sale quantities for the alternatives; however, it was applied across the combined HLC NF to reflect the desire for even timber flow.
- Dispersion of openings limits the amount of area within a management area group that can be regenerating at one time, to ensure that treatments are distributed spatially.
- Lynx habitat constraints include timing and treatment acreage limits apply to lynx habitat areas.
- Harvest and silviculture method constraints define the expected focus of treatments by management area group.
- Prescribed burning constraints set a minimum and maximum range of acres that reflects the capability of the forest to achieve the needed weather windows.

Constraints were also considered for requiring a minimum amount of old forest; limits on harvest in grizzly bear habitat; and goals specific to lynx multistoried habitat. However, preliminary model reviews showed that other design elements provided for these factors without specific constraints.

Disturbance processes

The amount of natural disturbances (stand replacing fire, mixed severity fire, and severe bark beetle infestation) expected in the future was determined using SIMPPLLE. Disturbance levels were input into Spectrum to ensure that the model took those disturbances into account when scheduling treatments. The following assumptions were used:

- The climate will be consistent with the hot/dry natural range of variation throughout the projection.
- For fire by vegetation type, the average from the first 5 decades is used for all model periods.
- Acres are not averaged for the size classes because the distribution of size classes might not accommodate the average values in a given timestep. Therefore, for fire acres by size class, there are minimum and maximum constraints set.
- Fire suppression was modeled by correlating 2000-2014 fire occurrence/size data (which resulted from current day suppression tactics).
- Severe bark beetle only includes mountain pine beetle in lodgepole pine. Because the HLC NF recently underwent a wide-scale outbreak, no substantial infestations are anticipated in the next several periods. The constraint is set to capture the episodic nature of mountain pine beetle.
- Minimum defined time periods must pass before a site is eligible to receive another disturbance of the same kind.
- Fire disturbances are more likely to occur in certain management area groups, based on fire management policies and accessibility for fire suppression.

Management objectives

Optimization models such as Spectrum minimize or maximize an objective function subject to constraints. For all alternatives, one objective function was to move towards the desired condition for vegetation. The desired conditions are defined by forestwide proportions of cover type, density class, and size class, and do not vary by alternative. Desired conditions for the model are based on those developed for the revised plan, but for Spectrum the ranges only represent forested acres and be stratified differently. The ranges depict the 25th-75th percentile range around the means across all areas and runs.

For alternative E, the model was also run with an objective function to maximize timber output levels in the first decade. The results were then ‘rolled over’ (achieving 95% of first decade harvest levels input as a constraint) and the model re-run with the objective to move towards vegetation desired condition.

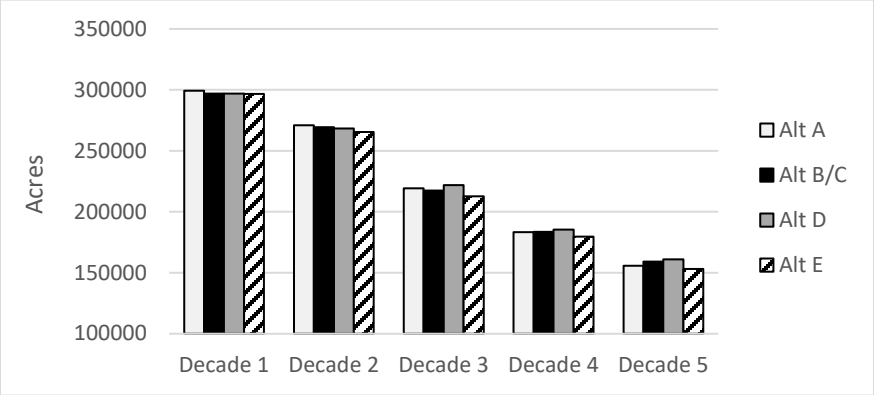
Spectrum Model Results

The following sections discuss key outputs across alternatives from the Spectrum model, with and without the budget constraint, for the first 5 decades of the modeling horizon.

Hazard of stand replacing fire and insects

The hazard of stand replacing fire in forested vegetation types was estimated in the yield tables used for Spectrum modeling, which were developed using the fire and fuels extension of the Forest Vegetation Simulator. The results do not include the iterative modeling with climate and disturbances that SIMPPLLE provides. This metric shows only the hazard of stand replacing fire, based on stand characteristics – it does not indicate fire risk or expected fire acres burned.

Figure 147. Acres with high hazard of stand replacing fire by alternative



Hazard to bark beetles (mountain pine beetle and Douglas-fir beetle) and defoliators (primarily western spruce budworm) was also estimated in the yield tables used for Spectrum modeling, which were developed using the Forest Vegetation Simulator (Randall & Bush, 2010).

Figure 148. Acres with high hazard to bark beetle infestation by alternative

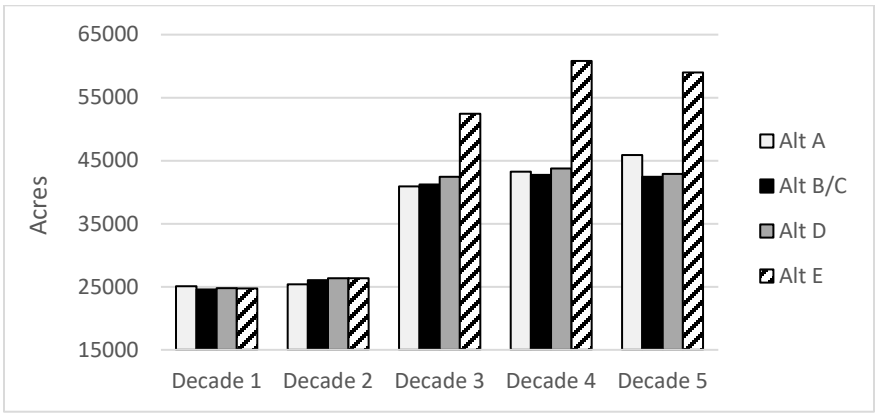
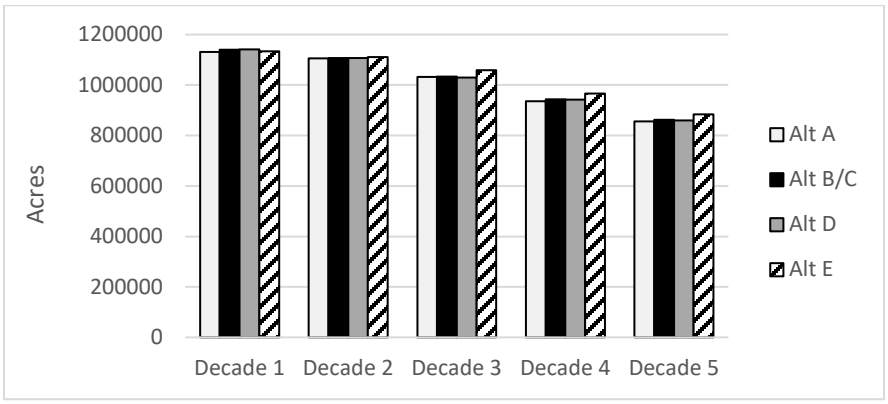


Figure 149. Acres with high hazard of defoliation by alternative



Acres of harvest

Harvest as modeled in Spectrum is of two general types: even-aged regeneration (clearcut, seedtree, shelterwood harvest and associated overstory removals), and non-regeneration (intermediate thinning and

uneven-aged harvest). The model scheduled treatments based on the condition of the landscape and the ability of treatments to move the forest towards the desired conditions, while considering all constraints.

Figure 150. Harvest acres by decade, by alternative, with and without budget constraint

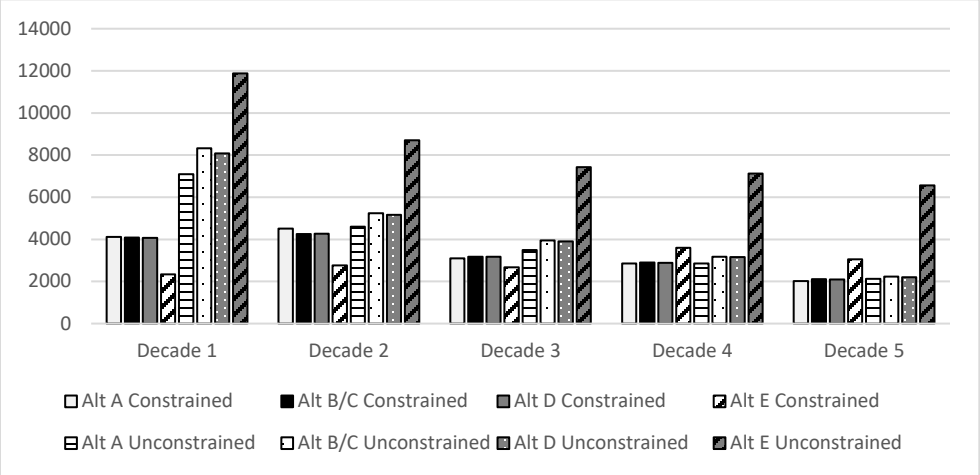
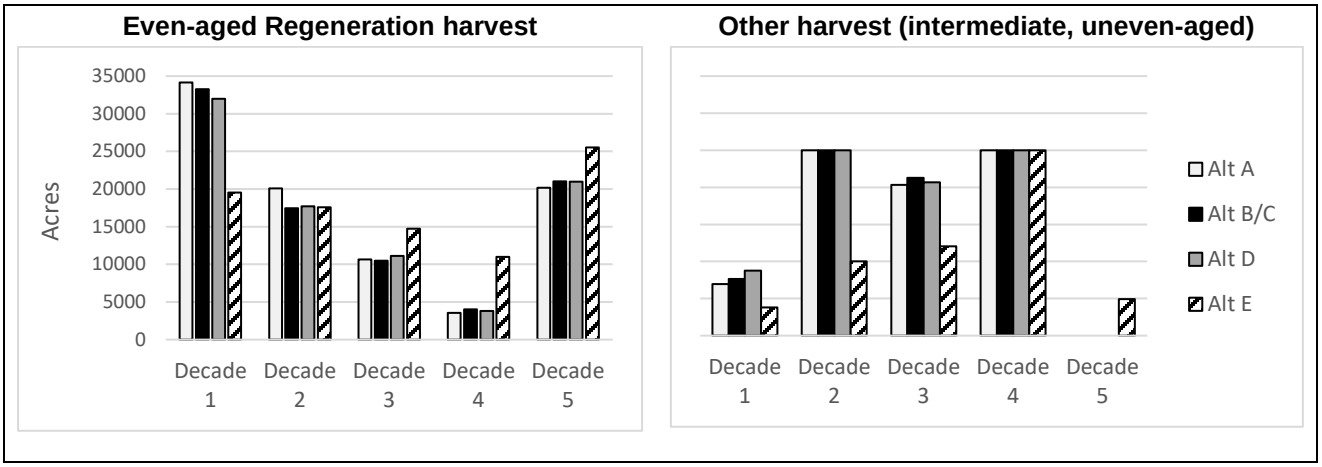


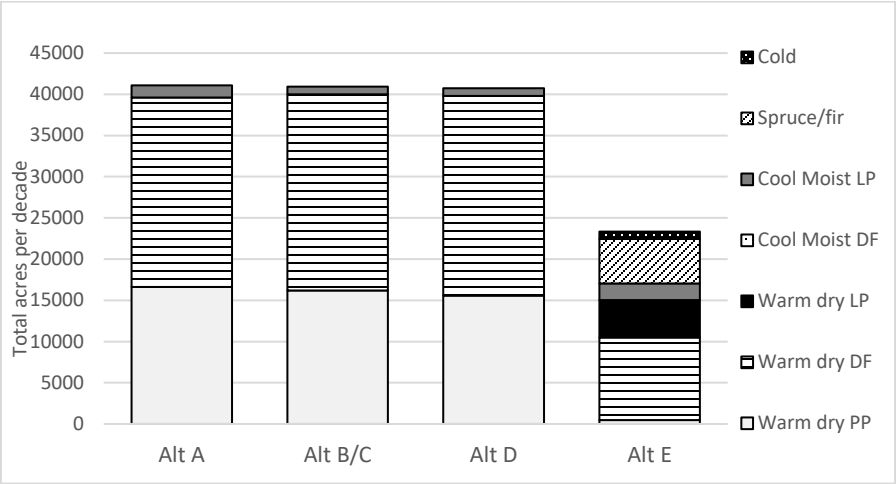
Figure 150 displays the projected acres of timber harvest by type for a five-decade period, on lands both suitable and unsuitable for timber production, assuming a reasonably foreseeable budget.

Figure 151. Acres harvested by decade and alternative by type, reasonably foreseeable budget



The projected harvest by vegetation type is displayed in the figure below.

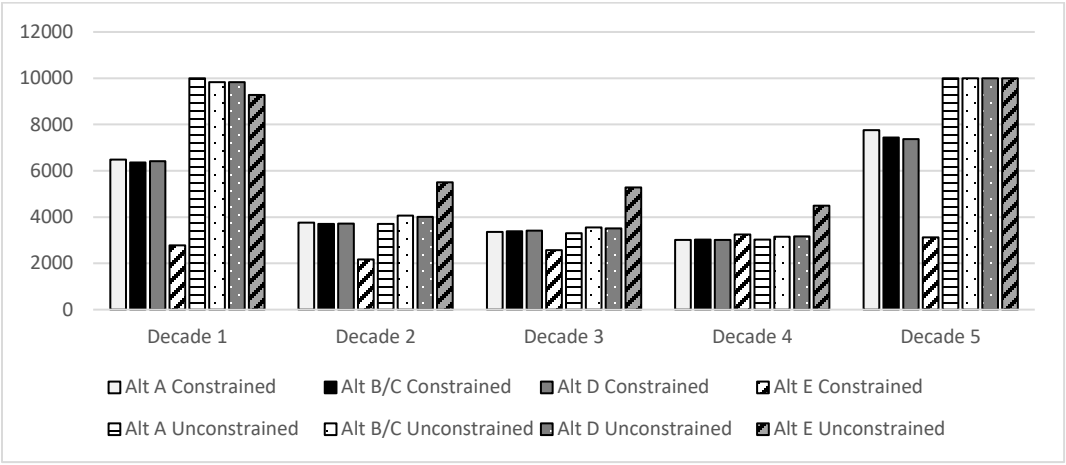
Figure 152. Projected harvest acres by vegetation type by alternative for decade 1



Acres of prescribed burning

Prescribed burning was also scheduled by Spectrum. Two types are included: low severity burning as an intermediate treatment or site preparation activity within a harvest prescription; and ecosystem burning that occurs as its own stand-alone prescription which could occur with a variety of severities depending on the vegetation conditions. The total acres include both types. The forest currently conducts 130,000 acres on average per decade, or 13,000 per year, based on accomplishment records from 1980 to 2013. The Spectrum projections are lower than this level but only represent forested vegetation.

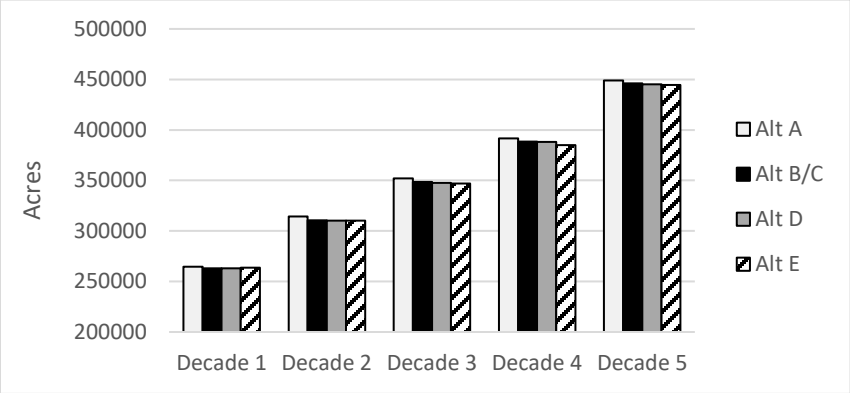
Figure 153. Prescribed burning acres by decade, by alternative, with and without budget



Old forests

Old forests were tracked in Spectrum. These forests are defined based on the minimum age identified in Green et al (1992) for each vegetation type. Many of these forests would not be old growth because they lack other characteristics. The amount of old forest estimated by Spectrum is less than the amount of old growth currently present, due to the generalization of age in yield tables. Therefore, this information provides only a relative potential trend across alternatives.

Figure 154. Acres of old forest forestwide, by alternative over 5 decades



Timber outputs: PTSQ and PWSQ

Spectrum provides estimates of the following timber volume outputs expected to be sold during the life of the plan, as required by the 2012 planning rule and associated directives (USDA, 2015):

1. Projected timber sale quantity (PTSQ), or the volume of timber that meets sawlog specifications;
2. Projected wood sale quantity (PWSQ), which includes the PTSQ timber volume plus other wood products such as nonsaw and biomass (we assume a 15% increase in volume to account for this material); and firewood (we assume a 1.35 mmcf increase in volume assumed based on the current firewood program);

Neither of these estimates includes potential salvage or sanitation harvest that may occur in response to disturbances. The expected timber outputs which are disclosed in Appendix C are based on fiscal capability and organizational capacity. For analysis purposes, these are also estimate without a budget constraint. Figure 154 and Figure 155 display the expected PSTQ and PWSQ by alternative, expressed as average annual figures by decade.

Figure 155. Projected timber sale quantities (average annual mmcf and mmbf) by alternative, with and without budget constraint

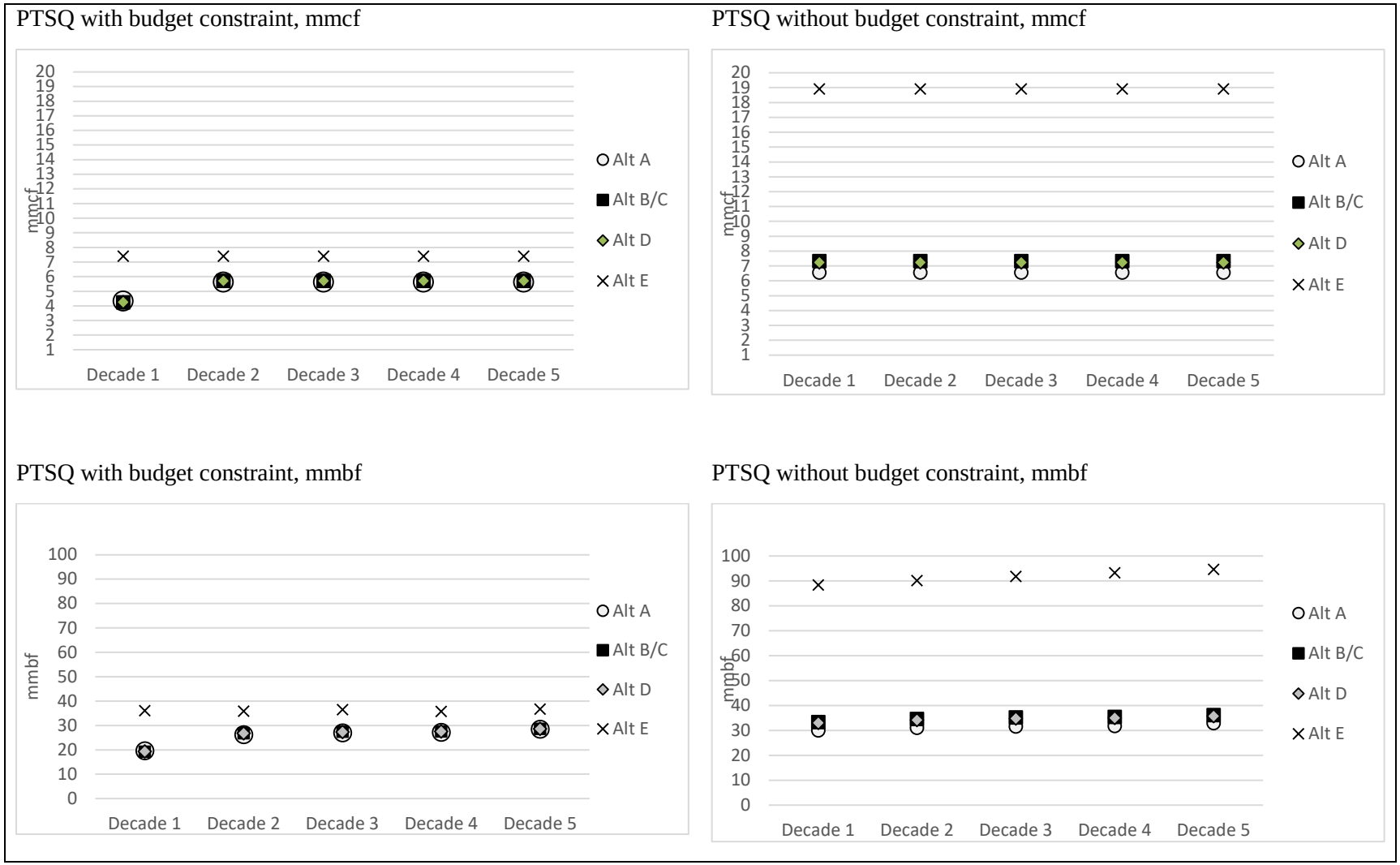
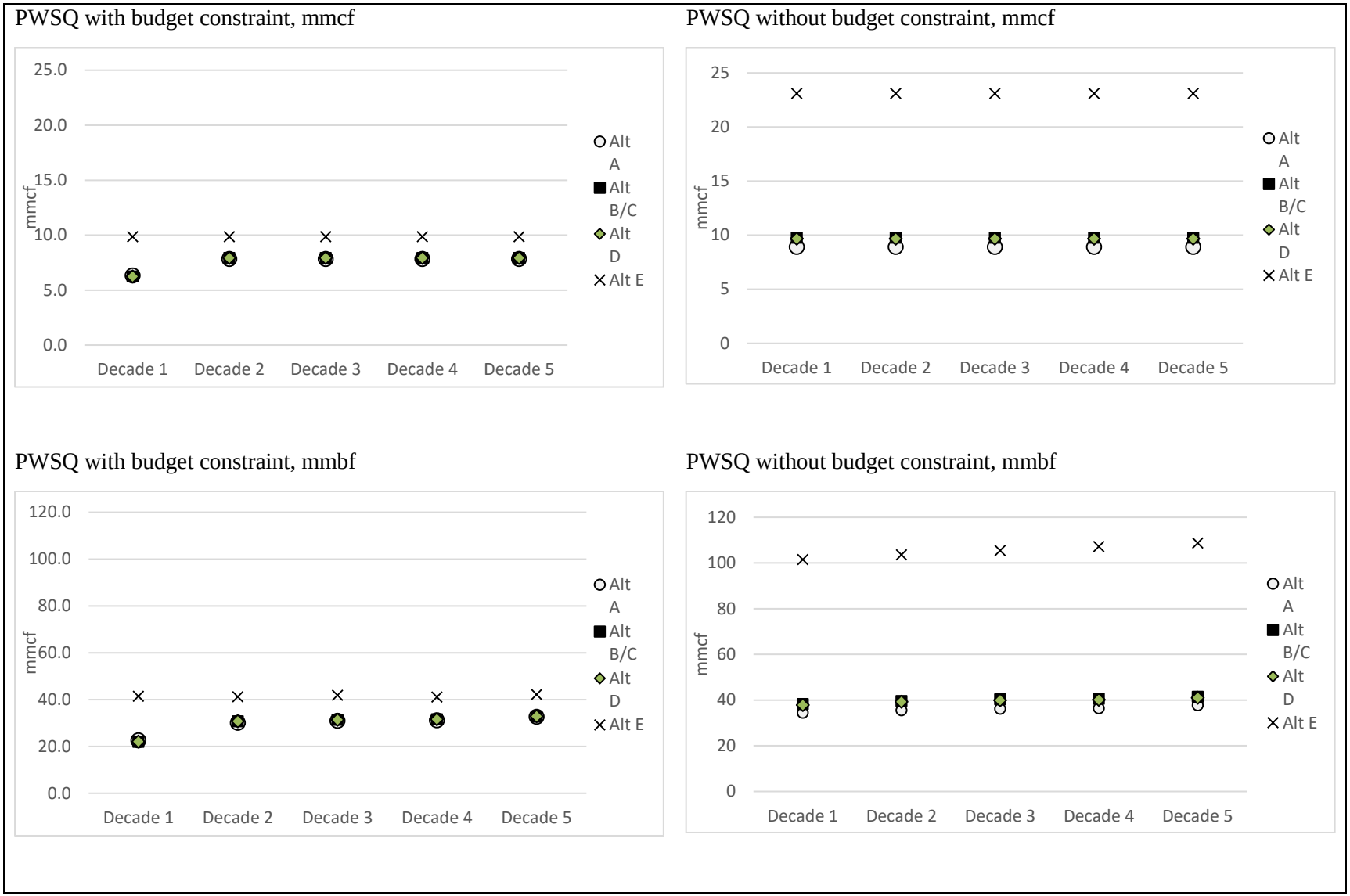


Figure 156. Projected wood sale quantities (average annual, mmcf and mmbf) by alternative, with and without budget constraint



Sustained yield limit

Spectrum also provides an estimate of the sustained yield limit, as required by the 2012 planning rule and associated directives (USDA, 2015). The sustained yield limit is the amount of timber meeting applicable utilization standards that can be removed from a forest annually in perpetuity on a sustained yield basis from all lands that may be suitable for timber production. It does not include potential salvage or sanitation harvest that may occur in response to disturbances. This value is not limited by desired conditions, other plan components (resource constraints), or the HLC NF's fiscal capability or organizational capacity. Sustained yield limits must be calculated for each proclaimed forest. A sustained yield limit of 5.03 mmcf (26.68 mmbf) was calculated for the proclaimed Helena National Forest; and 4.02 mmcf (21.30 mmbf) for the proclaimed Lewis & Clark NF, totaling **9.05** mmcf (**47.98** mmbf) for the administratively combined HLC NF.

The projected timber sale quantity (PTSQ) may not exceed this amount, unless a departure limit is specified by the responsible official for the first decade or two of the plan to achieve multiple-use management objectives. As shown in the figures above, alternative E, without a budget constraint, estimates a PTSQ above the sustained yield limit. This occurred because the objective of alternative E is to achieve 95% of the maximum timber possible from the Plan area. Emphasizing timber production in this way, and having no budget limitations, resulted in the model demonstrating a scenario in which PTSQ could theoretically exceed the sustained yield limit, due to two interrelated factors.

1. There is a difference in the landbase considered for the sustained yield limit versus lands where volume can be removed to contribute to the PTSQ. In all alternatives, some harvest is allowed to occur outside the lands that may be suitable for timber production. These are primarily lower productivity forests where harvest is used for restoration purposes. These lands were not included in the calculation of the sustained yield limit, but harvest volume from these lands contributes to the PTSQ. Although the model was calibrated to limit harvest in these areas in keeping with management objectives, alternative E (unconstrained) utilized harvest on these lands to the extent allowed.
2. The application of non-declining even flow is different between the sustained yield limit run and the projected alternatives. Non-declining even flow, or non-declining yield, means that the volume from a certain area is steady or increasing into the future. A non-declining even flow constraint was applied to each proclaimed national forest for the sustained yield limit. For the alternatives, the constraint was applied to the two forests combined. This allowed more flexibility in the timing and location of the sustainable harvest to best meet the desired conditions across the combined unit. It is also consistent with the current management paradigm for the HLC NF. The law and directives do not require a non-declining even flow constraint when estimating PTSQ or PWSQ; however, it was determined that this was important to provide for an even flow of timber. This resulted in the model being able to achieve more volume than would have been possible with the sustained yield limit run.

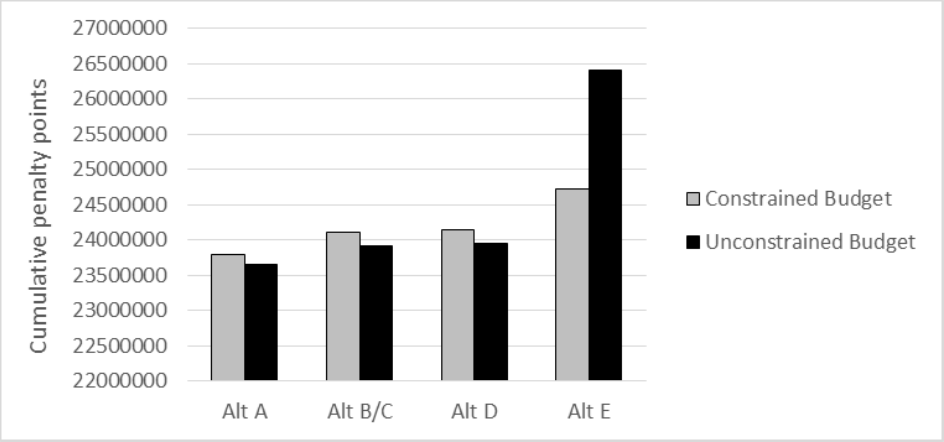
The modeling of alternative E, unconstrained by budget, provides insight into the potential level of timber volumes that could be achieved given more flexibility in scheduling where harvest occurs. However, the directives require that the Forest Plan display levels of harvest that are within the fiscal capability and organizational capacity of the HLC NF. Further, the selected PTSQ cannot exceed the sustained yield limit unless a departure analysis is done, and the increased volume could only occur for the first two decades. Because alternative E with an unconstrained budget is not within fiscal capability of the HLC NF and would not be selected for implementation, a departure analysis would not be conducted.

Desired condition penalty points

In the model, every acre that is not within the desired condition minimum and the desired condition maximum is assigned a "penalty point." Penalty points can accrue in any time period in the model, but

can become less as the forest moves toward desired conditions through time. The objective is to minimize total penalty points. Thus, alternatives with lower overall penalty points do a better job of moving vegetation towards desired conditions than those alternatives with higher penalty points. The desired condition penalty points provide a relative comparison of how well treatments in Spectrum contribute to terrestrial vegetation desired conditions; however, these results do not include dynamic interactions between treatments and ecological processes over time.

Figure 157. Desired condition Spectrum penalty points by alternative



Sensitivity analysis

Sensitivity analysis is conducted to examine the trade-offs caused by the constraints and determine if the Spectrum model is working correctly. 8 runs were made to test the major features and the effect of constraints. The sensitivity analysis runs used the analysis units from alternative B; results would be similar for all alternatives. All runs were made with the objective to move towards vegetation desired future condition. Table 16 describes the sensitivity analysis runs. Runs 1 through 6 are hierarchical, each building on the parameters included in the previous run to assess the incremental effect of adding constraints. Runs 7 and 8 isolate the effects of two key constraints (lynx and budget) against the baseline.

Table 16. Type, description, and purpose of sensitivity analysis modeling runs

Run	Description and Purpose
1	Baseline run. Model included only harvest flow and ending inventory constraints. The purpose of this run is to provide for comparison of the effect of other constraints.
2	Includes parameters for Run 1, plus the Management Area Group (MAG) treatment intensity constraints. These constraints ensured that the model focused harvest intensity in the appropriate areas (i.e., lands suitable for timber production).
3	Includes parameters for Runs 1 & 2, plus opening limits. The opening limits were designed to ensure harvests were distributed appropriately across the landscape.
4	Includes parameters for Runs 1, 2, & 3, plus lynx constraints. Lynx constraints were designed to ensure the Northern Rockies Lynx Management Direction is followed.
5	Includes parameters for Runs 1, 2, 3, & 4, plus additional operational limits (such as the minimum/maximum acres possible for burning, the appropriate silvicultural mix).
6	Includes parameters for Runs 1, 2, 3, 4, & 5 plus adds the budget constraint.
7	Includes parameters for Run 1 (baseline), plus the lynx constraints. This was done to isolate and understand the impact of lynx direction given no other model constraints.
8	Includes parameters for Run 1 (baseline), plus the budget constraint. This was done to isolate and understand the impact of the reasonably foreseeable budget constraint.

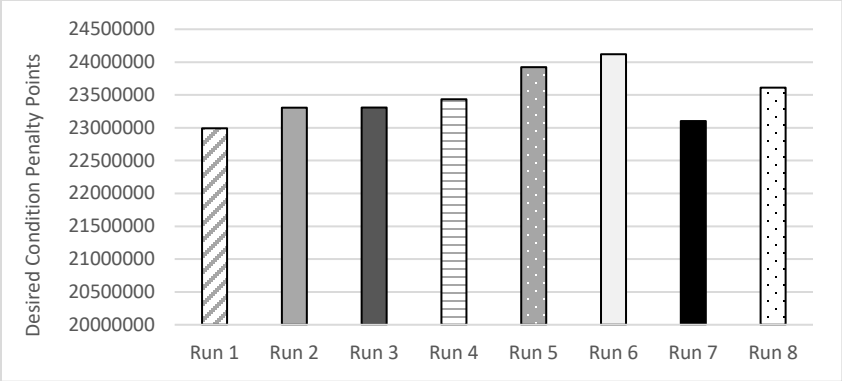
The results of the sensitivity analysis is displayed by comparing selected outputs. For most attributes, the budget was the most constraining factor, followed by operational and/or management area group constraints. For all outputs, runs 2 and 3 were identical, indicating that the opening limitations were not constraining. Run 3 is not compared in further detail.

Desired condition score

The first attributes compared is the desired future condition score (Figure 157). This score indicates the amount of penalty points incurred by the run; i.e., the higher the score, the worse the run does at achieving the desired condition. The points are accumulated over all 15 decades; the relative comparison of numbers is more important than the values. The best desired future condition score is attained under the baseline run (#1), with the most flexibility in management and no constraints. The desired future condition is not greatly affected by any one set of constraints in the model, but budget and operational limits are the most influential to achievement of the desired condition.

- Management area group constraints (run 2 versus run 1) reduce attainment of desired condition 1% compared to the baseline.
- Lynx constraints (run 4 versus 2) incrementally reduce the attainment of desired condition an additional 0.54%. Lynx constraints independent of other variables (run 7 versus 1) reduce attainment of desired condition 0.48% compared to the baseline.
- Operational constraints (run 5 versus run 4), incrementally reduce attainment of desired condition an additional 2%.
- Budget constraints (run 6 versus 5) incrementally reduce attainment of desired condition an additional 1%. Budget constraints independent of all other variables (run 8 versus run 1) reduce attainment of desired condition 3% compared to the baseline.

Figure 158. Desired future condition score across spectrum sensitivity runs



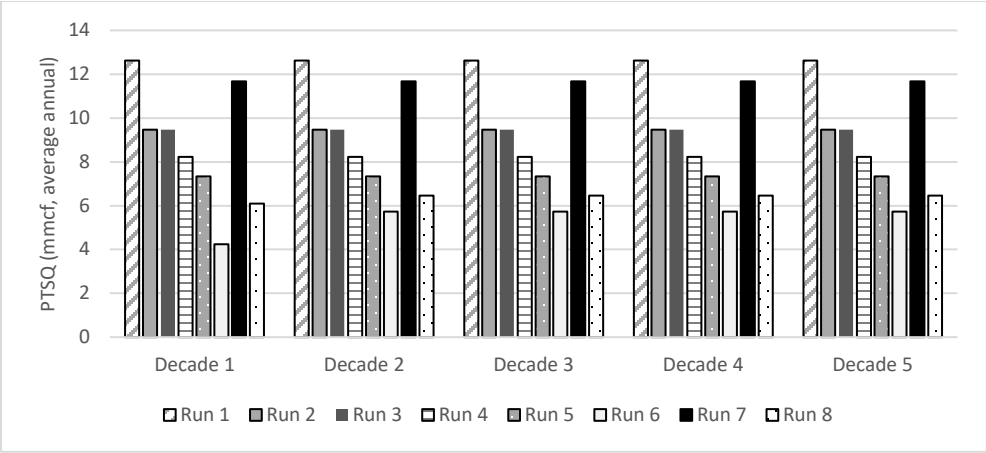
Projected timber sale quantity

The second attribute compared was projected timber sale quantity (PTSQ). Projected wood sale quantity trends are identical. The following summary compares the impact of constraints on the PTSQ estimated for Decade 1 of the planning period. Budget and management area constraints are the most influential to PTSQ, but it was also sensitive to lynx and operational constraints.

- Management area group constraints (run 2 versus run 1) reduce PTSQ 25% compared to the baseline.
- Lynx constraints (run 4 versus 2) incrementally reduce PTSQ 13%. Lynx constraints independent of other variables (run 7 versus 1) reduce PTSQ 8% compared to the baseline.
- Operational constraints (run 5 versus run 4) incrementally reduce PTSQ 11%.

- Budget constraints (run 6 versus 5) incrementally reduce PTSQ an additional 42%. Budget constraints independent of other variables (run 8 versus run 1) reduce PTSQ 52%.

Figure 159. Projected timber sale quantity across Spectrum sensitivity runs

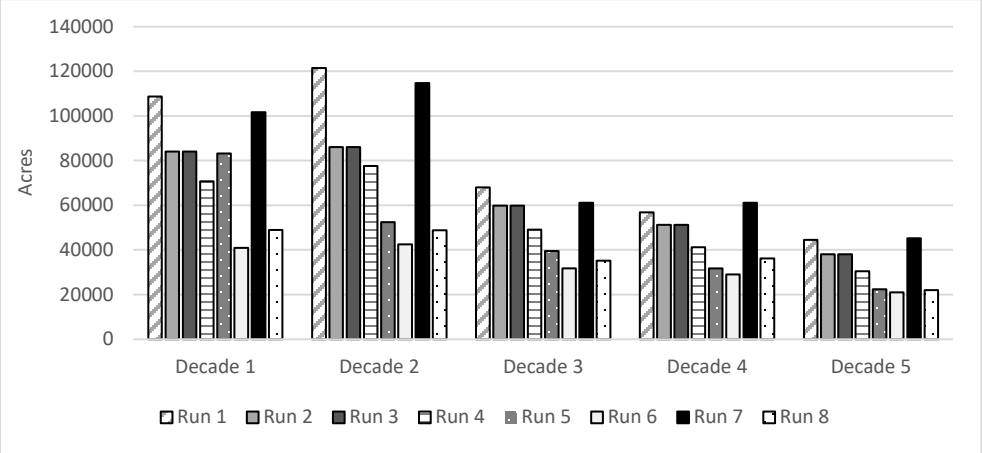


Projected harvest acres

The following summary compares the impact of constraints on the projected harvest acres estimated for Decade 1 of the planning period. Budget and management area constraints are the most influential.

- Management area group constraints (run 2 versus run 1) reduce harvest acres 23%.
- Lynx constraints (run 4 versus 2) incrementally reduce harvest acres 16%. Lynx constraints independent of other variables (run 7 versus 1) reduce harvest acres 6% compared to the baseline.
- Operational constraints (run 5 versus run 4) incrementally increase harvest acres in the first period by 18%, and then decrease the harvest level in future decades.
- Budget constraints (run 6 versus 5) incrementally reduce harvest acres an 51%. Budget constraints independent of all other variables (run 8 versus run 1) reduce harvest acres 55%.

Figure 160. Projected harvest acres across Spectrum sensitivity runs

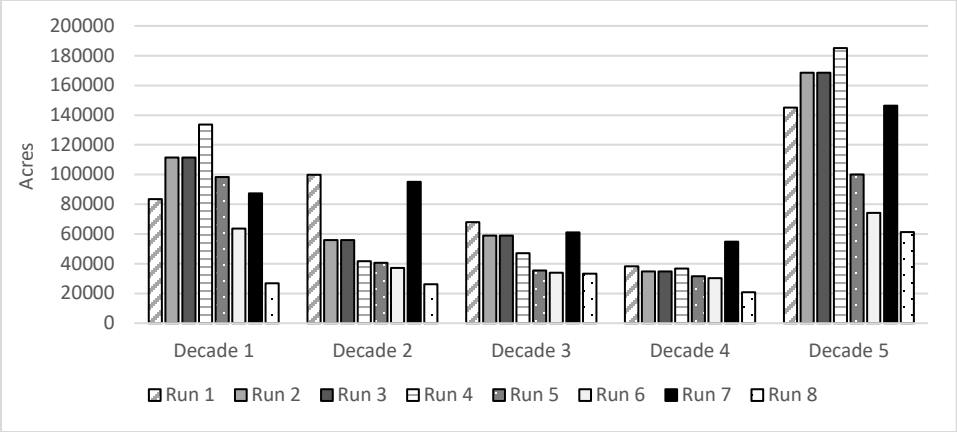


Projected prescribed burning acres

The following summary compares the impact of constraints on the projected burning acres estimated for Decade 1 of the planning period. Budget and management area constraints are the most influential. Some constraint sets have mixed influences (decreasing versus increasing burn acres) in future decades. Constraints that may limit harvest (i.e. lynx) result in increased burning.

- Management area group constraints (run 2 versus run 1) increase burning acres 34%.
- Lynx constraints (run 4 versus 2) incrementally increase burning acres 20% in Decade 1. Lynx constraints independent of other variables (run 7 versus 1) increase burning acres 5%.
- Operational constraints (run 5 versus run 4) incrementally decrease burning by 27%.
- Budget constraints (run 6 versus 5) incrementally reduce burning acres 35%. Budget constraints independent of all other variables (run 8 versus run 1) reduce burning acres 68%.

Figure 161. Projected prescribed burning acres across Spectrum sensitivity runs

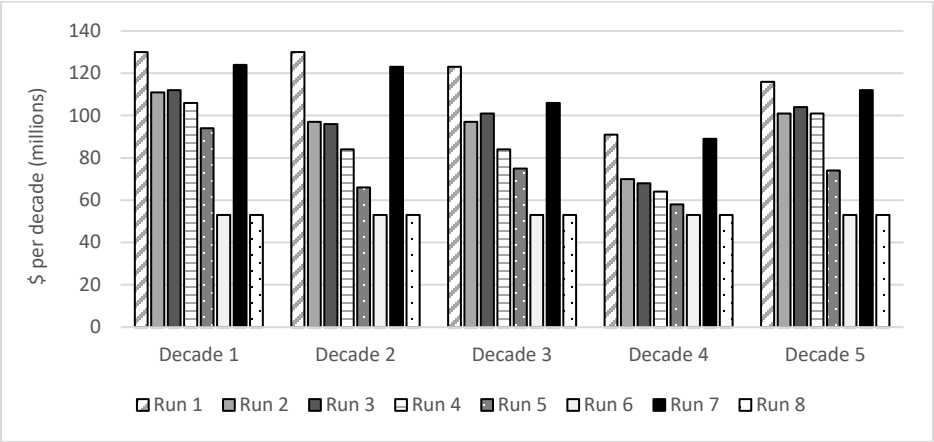


Budget

The total management costs, or how much of budget was used, was also evaluated. The addition of management constraints results in lower costs compared to the baseline scenario, because the amount of activities that can be done becomes limited. However, none of these constraints reduce the management costs below the budget limitation that is applied in run 6 and 8. The following summary compares the impact of constraints on the budget for Decade 1 of the planning period. Runs 6 and 8 are identical because they both employ the reasonably foreseeable budget constraint.

- Management area group constraints (run 2 versus run 1) reduces budget used by 15% compared to the baseline scenario.
- Lynx constraints (run 4 versus 2) incrementally reduces budget used by 5%. Lynx constraints independent of other variables (run 7 versus 1) reduce costs 5% compared to the baseline.
- Operational constraints (run 5 versus run 4) incrementally decreases budget used by 11%.
- Budget constraints (run 6 versus 5) incrementally reduce budget used 44%. Budget constraints independent of all other variables (run 8 versus run 1) reduce budget used 59%.

Figure 162. Comparison of projected budget used across Spectrum sensitivity runs



Geology, Energy, and Minerals

There are approximately 2,883,226 acres of NFS lands that are the administrative responsibility of the Forest. This is the result of the original Congressionally-designated lands and the conveyances (acquisitions, disposals, and exchanges) that have occurred to date.

The acres that are available for locatable mineral resource development are determined by subtracting the number of acres that are withdrawn from locatable mineral entry from the total number of acres for the HLC NF. The number of acres that are withdrawn from mineral entry is a matter of record. By law, the Bureau of Land Management keeps official records in the General Land Office.

The number of acres that are available for leasing proposals is determined by subtracting the number of acres that are legally unavailable from the total number of acres on the HLC NF. There are no active leases on the forest aside from 3 leases which are subject to litigation (Badger Two Medicine and Connor v. Burford). No activity can take place on any active leases until an EIS is completed. A leasing decision will not be a part of this Forest Plan Revision.

Lands which are legally unavailable for leasing are:

- Lands withdrawn from mineral leasing by an act of Congress or by an order of the Secretary of the interior;
- Lands recommended for wilderness allocation by the Secretary of Agriculture;
- Lands designated by statute as wilderness study areas, unless oil and gas leasing is specifically allowed by the statute designating the study area; and
- Lands within areas allocated for wilderness or further planning in Executive Communication 1504.

The number of acres that are available for disposal of mineral materials is determined by subtracting from the total number of acres on the HLC NF the number of acres where the FS has exercised its discretion to refrain from authorizing the disposal of mineral materials.

Carbon Sequestration

Existing regional-scale climate projections are used to understand the type and magnitude of climate change effects that could occur. The most recent National Greenhouse Gas Inventory (EPA, 2015) provided information at the national level on forest contributions and conditions related to carbon sequestration. The update to the FS 2010 Resources Planning Act Assessment (USDA 2016) was also a source of summary information on recent findings related to forest carbon conditions on all forest lands in the U.S., and projected future carbon stocks and flows were also provided.

Climate projections embody a number of uncertainties, the sources of which include the uncertainty of future emissions driven by socioeconomic processes and unpredictable policy choices, variability internal to a given global climate model's simulation of weather and climate, variability related to parameterization and other model characteristics, and uncertainty or error in observed climate data used in downscaling global climate model output (Daniels et al., 2012). Uncertainty also exists regarding ecosystem carbon stocks. The uncertainty of forest carbon flux at the national-scale often ranges between 15-25%, suggesting that uncertainty simulations at the individual national forest scale should exceed 25% (USDA 2015). The critical sources of uncertainty in the harvested wood products analysis include, but are not limited to, reported harvest, timber product ratios, primary product ratios, conversion factors, end use product ratios, product half-lives, disposition ratios, decay limits, landfill half-lives, dump half-lives, and burned with energy capture ratio (Stockmann et al., 2014). The range of distributions found in the uncertainty analyses conducted for these sources ranged from +/- 5 to 30% (Stockmann et al., 2014).

There are three models used to develop regional and forest-scale carbon estimates, as reported in publications from the Forest Service Climate Change Advisor's Office (USDA 2017; USDA 2015). These models provide the foundation for this analysis.

1. The Carbon Calculation Tool uses Forest Inventory and Analysis program data to estimate baseline carbon stocks and carbon stock change from 1990 to 2013, based on data from two or more years of inventories conducted since 1990 (Woodall, Smith, & Nichols, 2013). Carbon stocks are estimated by linear interpolation between survey years. Recent estimates of baseline carbon stocks and trends for forests and harvested wood products have been provided for forestlands on national forest land in the United States (USDA 2015).
2. The Forest Carbon Management Framework (S. P. Healey et al., 2016; Sean P. Healey, Urbanski, Patterson, & Garrard, 2014) estimates the effects of individual disturbances such as fires, insects, harvests, and weather on non-soil carbon storage from 1990-2011 by integrating remotely sensed disturbance maps (Sean P. Healey et al., 2014) along with Forest Inventory and Analysis data and a growth and yield model (S. P. Healey et al., 2016; Raymond, Healey, Peduzzi, & Patterson, 2015). This model estimates how much more carbon would be stored in the forest if those disturbances had not occurred and provides information on the patterns of disturbance and how disturbances has impacted carbon storage.
3. The Integrated Terrestrial Ecosystem Carbon model (Chen, Chen, & Cihlar, 2000; Zhang et al., 2012) uses FIA program data, Landsat disturbance data, plus environmental data (climate, atmospheric concentrations) to determine if a forest is accumulating carbon (a sink) or losing carbon (a source). It determines the relative effects of disturbances and environmental/non-disturbance factors on the changes in carbon stocks and the accumulation of carbon from 1950 through 2010 and puts the effects of disturbance and management activities into the context of broader environmental and climatic processes.

The models produce very similar results (i.e., sink vs. source), but use different datasets and modeling approaches, so results vary. Though these models use some of the same data sets as other models used in baseline carbon assessments and for calculating existing carbon stocks, results are not entirely compatible. This is because these models integrate high resolution remotely sensed disturbance maps from satellite imagery; report different carbon pools; have differences in timing of data sources (remotely sensed data is more up-to-date than Forest Inventory and Analysis data); and the models themselves are different. Refer to the methodology, uncertainties, and interpretation of model result sections within the regional disturbance assessment (USDA 2017) for detailed information regarding appropriate interpretation of results and comparison to other estimates. Using these models, forest carbon disturbance assessments expand upon assessments of baseline carbon stocks across national forests by assessing how stocks are affected by timber harvesting, natural disturbances, land-use change, climate variability, increasing atmospheric carbon dioxide concentration, and nitrogen deposition (ibid). The assessment assists in the evaluation of effects of forest management strategies and potential disturbance factors on

carbon flux in the plan area. To generate forest carbon and disturbance assessments at the regional-scale, the analyses and models were carried out for the individual national forests and summarized across the region. Thus the analyses for the national forest scale use the same modeling framework and tools.

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Appendix C. Aquatic Ecosystems Best Available Science

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Introduction

This appendix provides a summary of the best available science (BASI) used to support the aquatic ecosystems analysis found in the body of the DEIS.

Streams and riparian areas

Stream and riparian area management

Studies in the 1960s and 1970s documented harmful effects that timber harvest and road-building at that time had on streams, and in response, agencies began passing a series of management requirements for activities on state and federal lands near streams. These are referred to as "best management practices" (BMPs). Everest and Reeves (2007) disclosed the following regarding the development of BMPs for the Pacific Northwest: "They [BMPs] were developed through the normative process that weighed, evaluated, and incorporated many types of information. The BASI for protection of riparian and aquatic habitats was not always incorporated into forest practice rules" (p. 77). This was repeated several times even as successive monitoring efforts continued to document degraded stream conditions (Gordon H. Reeves et al., 2016).

A crisis point was reached in the early 1990s in the western U.S. when several stocks of salmon and trout were reaching critically low numbers (Nehlsen, Williams, & Lichatowich, 1991) and ultimately were listed as threatened or endangered under the Endangered Species Act (ESA). By the mid-1990s, the FS and BLM had completed three broad-reaching documents (hereafter referred to collectively as "the strategies") that amended forest plans across much of the public lands in the northwest to improve their conservation function. INFISH (U.S. Department of Agriculture, 1995) addressed inland native fish habitat management including bull trout that were not covered within the geographic scope of the Pacific Anadromous Fish strategy (PACFISH). This includes parts of Idaho and Montana including the Blackfoot and Upper Clark Fork drainage.

One feature of the strategies was the extension of the distance from the stream of riparian management zones (RMZs; i.e., riparian reserves in the Northwest Forest Plan) and riparian habitat conservation areas to better protect ecological processes next to streams. Also, the precautionary principle was invoked. Reeves et al. (2016) described this principle as, "Forest managers who wanted to alter the comprehensive default prescriptions for riparian management under the [Northwest Forest Plan] in order to pursue other management goals were required to demonstrate through watershed analysis that changes would not compromise established riparian-management goals." Not only did the burden of proof shift, these new strategies also required managers to consider ecological processes at the watershed scale. The components used in the Northwest Forest Plan, including the concept of the precautionary principle, were included in PACFISH and INFISH.

Riparian management has remained controversial, in part because of competing values and uses (Lee, Smyth, & Boutin, 2004). Strategies employed by the Northwest Forest Plan, PACFISH, and INFISH appear to have been successful at halting the loss of old growth due to harvest within riparian areas and limiting damage to aquatic systems in the Pacific Northwest (J. W. Thomas, Franklin, Gordon, & Johnson, 2006) and the intermountain region. However, some suggest a protection mindset emerged that has prevented management within riparian areas that would be desirable to sustain and/or promote ecological processes beneficial to aquatic or terrestrial ecosystems (Liquori, Martin, Coats, & Ganz, 2008; Ryan & Calhoun, 2010; J. W. Thomas et al., 2006). Speaking of the need to restore ecological conditions and make good on social, economic, and ecological commitments in the Northwest Forest Plan, Thomas et al. (2006) wrote, "Minimization of short-term risks (the modus operandi of regulatory agencies and the

federal courts) has a price tag, and a very big one, related to significantly increased longer-term risks of failure to meet objectives over very long time frames. Unless the federal agencies consider the peril of inaction equal to the peril of action, the goals of the [Northwest Forest Plan] will not be reached." Richardson, Naiman, and Bisson (2012) wrote: "In an increasingly complicated management arena, the challenge will be to find alternatives to fixed width buffers that meet the multiple objectives of providing clean water (minimizing nutrient and sediment inputs), aquatic habitat, habitat for riparian species, connectivity across landscapes, and related responses."

Bank stability and livestock grazing

Bank stability is discussed here as an ecological process; especially as it relates to the effects of anthropogenic activities. In addition to bank degradation that could occur as a result of vegetation management, it can also occur from dispersed recreation and grazing.

Bank stability on low gradient stream reaches that support cold water fish species are of particular concern and are susceptible to livestock overuse. Riparian vegetation that stabilizes the banks has the best opportunity to slow velocity and induce deposition of materials, and re-create channel pattern, profile, and dimension appropriate for the landscape setting. Where streambank instability due to vegetation removal or changes in channel form may arise from channel widening or channel incision, vegetation along the greenline is most critical for maintaining stability. When livestock grazing is closely managed and monitored by professional land managers, assumptions are made that some degree of cattle use is compatible with riparian ecosystem management and that trends towards desired conditions can be achieved while cattle graze the area (Armour, Duff, & Wayne, 1994; Robert L. Beschta, Bilby, Brown, Holtby, & Hofstra, 1987; Bryant et al., 2004; Clary & Webster, 1990; Johnson, 1992; Platt, 1991); Hanson 1993, Ratcliff et al. 1987, Skoviin 1984).

Most of the literature reviewed pertains to varied conditions found in western riparian areas and is most applicable to riparian areas in sagebrush grasslands, western interior forests and prairie settings. Many of these rangelands can be affected by varying amount of grazing use. A publication discussing grazing in southwest Montana disclosed some of the history of grazing and focused attention on the stream channel response and management options (Bengeyfield, 2006). Extensive grazing by both wild and domestic ungulates can remove woody plants (Batchelor, Ripple, Wilson, & Painter, 2015), reduce the vigor of perennial forbs and grasses, and cause channel profile and function changes via bank collapse on low gradient streams (Bengeyfield, 2006; Trimble & Mendel, 1995). Widening channels, increased stream temperature, increased fine sediment, altered bank structure and loss of overhanging vegetation that may occur from excessive grazing (Kershner, Roper, Bouwes, Henderson, & Archer, 2004; Myers & Swanson, 1996) is often harmful to aquatic fauna, especially cold-water dependent species (Belsky, Matzke, & Uselman, 1999; Saunders & Fausch, 2007). Furthermore, some studies have demonstrated trout respond positively to livestock exclusion (Sievers et al. 2017), though mechanisms are not clearly understood.

Large wood

The fate of large wood in streams has been an important focus for aquatic scientists and managers in the western U.S. for decades (Richardson et al., 2012). Up until the 1980s, many managers were concerned about how wood in streams affected water quality and about how accumulations of wood in streams could sometimes block fish migration. These concerns led to instream wood removal programs (Mellina & Hinch, 2009). By the 1980s, scientists more fully recognized wood's role in channel formation and maintenance (J. W. Thomas & Raphael, 1993). As with stream temperature, the precautionary principle applied by the strategies to riparian reserves and riparian habitat conservation areas also ensured that the interim widths were set wide enough to encompass any trees that could be delivered to streams, especially the two-tree width for fish-bearing streams (Everest & Reeves, 2007).

Regarding the riparian width needed to ensure streamside wood delivery to streams, debate and scientific inquiry has continued since the strategies were adopted. Studies have been completed to help identify where wood in streams comes from (L. Benda, Miller, Bigelow, & Andras, 2003; Gordon H. Reeves, Burnett, & McGarry, 2003) and the fate of wood once it is delivered above or to the stream (Beechie et al. 2000). In addition to streamside delivery, disturbance combined with topography can deliver a significant percentage from outside riparian management zones, especially steeper watersheds that are more dissected. Models have also been developed to help identify the likelihood of riparian trees being delivered to the stream channel (L. Benda et al., 2003; Meleason, Gregory, & Bolte, 2003; Pollock, Beechie, & Imaki, 2012; Spies, Pollock, Reeves, & Beechie, 2013; Welty et al., 2002). Models focused on wood delivery from the riparian areas consider distance from the stream, median tree height, and the direction that trees fall. Benda and others. (2016) also discuss how to implement tree tipping (manually falling trees into a stream) to balance the effects of thinning dense second-growth stands to accelerate large wood development. Modeling completed by Meleason and others (2003) found that > 90 percent of wood was contributed from within 30 meters of the stream edge for modeled conifer riparian stands in western Oregon and Washington. In a literature review, Spies and others (2013) found that 95 percent of wood delivered to streams from hardwood stands came from within 82 feet, and from conifer stands from within 148 feet, in forests in the western cascades of Oregon and Washington.

Livestock grazing

The primary grazing areas that have low enough precipitation and high enough evaporation rates to support grass communities, instead of coniferous stands, tend to occur in the warmer, lower elevation areas that may also include losing stream reaches. Although the losing flows in these areas tend to be principally geologically controlled, grazing related impairments can also contribute to stream-flow loss. Mechanisms include reductions in shade canopy, disruption of beaver created water storage in flood-plains, and altering width-depth ratios. These same impairment related mechanisms often lead to an increase in water temperatures in the stream. An additional grazing related impairment is increased sediment yields and in-channel storage of fine sediments, which also impact stream channel form, function and fish habitat. Across the plan area, fine sediments are almost always darker in color than native gravels and larger sized substrates. The combination of a higher width-depth ratio and a reduced shade canopy results in higher solar radiation absorption increasing water temperatures, decreased food production and reducing the quality of aquatic habitat.

Wildland fire

Under natural fire regimes, whether fire did or did not burn into riparian areas, or whether they burned at low, moderate or high severity, was influenced by a combination of factors, including weather (i.e., wind speed and direction), fuels/vegetation conditions (i.e., moisture level, downed wood, forest densities and tree species), terrain (i.e., steepness as it may affect spread of fire), climatic conditions (i.e., drought period), and just plain chance. See fire and fuels section for a description of fire history in the plan area.

Fire occurrence historically varied with vegetation type, aspect and elevation differences, high severity fires occurrence in forested vegetation types ranged from 35 – 200 years and were typically associated with extended dry climatic periods. These types of fires would often burn at high or moderate severity through riparian areas as well, especially in the steep, deeply incised stream channels typical across much of the planning area. These fires convert forests to an early successional stage dominated by grasses, forbs, shrubs and seedling trees. Though openings might be large and extend to the edge of streams or wetlands, in the relatively moist sites of riparian areas they typically revegetate rapidly. There is often a higher diversity and density of plants in riparian areas in this early successional stage compared to upland terrestrial sites, including broadleaved trees (such as aspen, birch and cottonwood) that benefit from the open forest conditions.

Motorized trails, travel management, and roads

Road networks have been shown to have detrimental effects on water and aquatic resources in forested landscapes. Road systems can change a natural hydrologic regime by altering natural flow patterns and increasing sediment delivery to streams. Roads have been shown to destabilize side-casted material and hillsides, expand the lengths of gullies and stream channels, increase sediment delivery, and alter streamflow and channel adjustments (Furniss, Roelofs, & Yee, 1991; Quigley & Arbelbide, 1997).

Natural drainage patterns are affected long-term by the mere presence of roads. Roads intercept subsurface drainage in cut slopes, capture rainfall on hardened road surfaces, and route excess runoff into the stream channel system. These impacts increase as the road system becomes more connected, in terms of hydrology, to the natural channel network. Where a dense road network is well connected to the stream network, it can be an "extension" of the actual stream network and alter streamflow regimes. These alterations can increase the delivery of water to the mouth of a watershed during snow melts and storm events, which can increase peak flows in streams and water levels in ponds, lakes, and wetlands.

Sediment from the road system can be delivered to streams by direct erosion of cut and fill-slopes associated with stream crossings or by surface runoff from roads and ditches that carries sediment-laden water directly or indirectly to streams. In general, roads lacking surface rock, those with steep grades and steep side slopes, and those that cross streams or are in proximity to streams are the greatest contributors of sediment from surface erosion. In steep terrain, roads can increase the rate of hill slope failures and soil mass wasting. Excessive fine sediment loading can lead to changes in channel morphology and water temperature because of pool filling, widening of the channel, and making the channel shallower, which can result in water temperature increases as a result of having a shortened water column that takes less solar energy to heat. Such changes in channel morphology are typically found at road-stream crossing locations and in response to mass failures associated with road runoff. Sometimes roads capture flow out of the channel and result in the stream re-routing down the road, which typically results in road failure and more sediment delivery to streams.

Vehicular traffic also contributes to sediment delivery from roads, particularly if ruts develop in the road and if traffic is heavy during shoulder seasons when the ground is more saturated. Hauling during timber sales is typically down the same road system for weeks or months at a time, thus the quantity and repeated nature of this traffic make it a systematic, recognizable source of sediment on forest roads.

The location and design of valley bottom roads also create long term effects on water resources. Many older roads were constructed very close to stream channel areas, often in the floodplain. Poorly placed roads can encroach on stream channel and floodplain areas. Roads can affect stream channels directly if they are located on active floodplains or directly adjacent to stream channels. Often streams were straightened to accommodate road placement. For example, a road located adjacent to a stream can be a chronic source of sediment. If the road changes the morphological characteristics of the stream, this can set forth a chain reaction of channel adjustments that can result in accelerated bed and streambank erosion, which produces excessive sediment.

Not all sediment production from roadways reaches the aquatic system. Many of the aforementioned effects of roads can be mitigated by design changes that disperse, rather than concentrate road runoff. Good design provides stable cut and fill slopes and adequate drainage that allows water to filter through vegetated strips or sediment traps before entering the stream channel. The effectiveness of vegetative strips generally increases with increased width and lower hillslope gradient. However the effects of large-scale or chronic road impacts may still impact streams even when streams are protected by wide and intact vegetative strips.

Other design elements used to mitigate road interception and runoff are the addition of gravel surfacing and seasonal road closures. Road treatments can upgrade or remove problem culverts to allow sediment and wood to move downstream instead of accumulating upstream of roads and leading to culvert blockage and failure. However, temporary, short-term, and long-term sediment and turbidity increases can occur from project implementation, as well as from post-project stabilization.

Turbidity and sediment increases result from the construction of roads, road grading, ditch cleaning, culvert replacement, road ripping or decompaction, and the installation of water bars due to the heavy equipment excavation that these activities require. Minor amounts of fine sediment would be delivered to streams during implementation of road treatment activities and during the first substantial runoff event. Subsequent runoff events would contribute less sediment production over time but are expected to last up to one year later or until vegetation is established on bare-soil areas adjacent to streams. Design criteria and BMPs are used to minimize the amount of fine sediment entering stream channels while work is in progress and after the work is completed, including promoting vegetation establishment through seeding.

Roads that are at high risk of failure and have the potential to cause extensive resource damage are candidates for relocation or decommission. Preferred locations for roads are away from stream channels, riparian areas, steep slopes, high-erosion-hazard areas and areas of high mass movement. Realignment of roads so they traverse riparian areas and streams at perpendicular angles rather than parallel angles would improve the quality of riparian and aquatic habitats in presently impacted stream reaches by reducing chronic sediment sources. If relocation is not possible, seasonal restrictions could limit road damage and subsequent sedimentation.

The potential risk of detrimental effects exists as long as the road is retained. The continued use and existence of roadway segments that interact with stream corridors pose a risk of erosion, slope failure, and sediment delivery to receiving waters. Road obliteration reduces the long-term risk of sediment delivery to streams from roads and road-side ditches through reducing culvert failures and landslides, eliminating vehicular traffic, improving infiltration of water into the ground through decompaction of road surfaces, and reducing overland and ditch flow into streams. While some sediment is expected to be delivered to streams during culvert removal and decommissioning processes, the amount of sediment delivered to streams is expected to be significantly less than would occur if the roads were left under current maintenance. Cook and Dresser (2007) found that stream-crossings that were restored through decommissioning delivered only 3 to 5 percent of the amount of fill material that was originally located at each crossing.

Removal or closure of roads adjacent to streams can have a short and long-term positive effect on soil-hydrologic function, soil productivity, and stream water temperature. Trees and other riparian vegetation can re-colonize a ripped roadbed and help provide shade. How much water or stream temperature improves depends on the existing stream shade to block solar radiation and water temperature, the stream’s size, and how much riparian road is removed or closed.

Riparian management zones

The most important change between the current 1986 plan directions for the HLC NF and the new 2012 planning rule (36 CFR 219.8) is the requirement to establish riparian management zone (RMZ) widths. The 2012 Planning Rule directed that during plan revision efforts, RMZs shall be established in all NFS lands. The 2012 Planning Rules states that the:

> (ii) Plans must establish width(s) for RMZs around all lakes, perennial and intermittent streams, and open water wetlands, within which the plan components required by paragraph (a)(3)(i) of

this section will apply, giving special attention to land and vegetation for approximately 100 feet from the edges of all perennial streams and lakes.

(A) RMZ width(s) may vary based on ecological or geomorphic factors or type of water body; and will apply unless replaced by a site-specific delineation of the riparian area.

(B) Plan components must ensure that no management practices causing detrimental changes in water temperature or chemical composition, blockages of water courses, or deposits of sediment that seriously and adversely affect water conditions or fish habitat shall be permitted within the RMZs or the site-specific delineated riparian areas.

The Helena NF Plan had riparian areas designated west of the Continental Divide by Amendment Number 14 in 1996, i.e. the 1995 Inland Native Fish Strategy (INFISH) decision. The rest of the HLC NF does not have riparian management areas currently designated.

This section provides background information and a summary of the best available science (BASI) that was used to identify the appropriate widths for designating riparian management areas on the HLC NF.

Ecological functions and width

Regarding the widths of management areas next to streams, the interim minimum distances listed in INFISH for fish-bearing streams west of the continental divide (300 feet) and permanently flowing non-fish-bearing streams (150 feet) arguably remain the most controversial components of the existing strategies. Numerous studies have been completed since the strategies were first published that investigate how management affects the different ecological processes that are a function of riparian management zones. Though most studies were conducted for riparian habitats west of the continental divide, they were applied throughout the planning area. The ecological processes that function within riparian zones are first discussed individually below and then in combination, as they affect both aquatic and riparian conditions and biota.

After considering new science, Reeves and others (2016) proposed two options to direct management in riparian management zones in the Northwest Forest Plan area. The first option the authors considered was a “one-size-fits-all-approach,” that retains the fixed buffer width where the inner 75 feet next to the stream is managed strictly to conserve aquatic function and the outer 75 feet allows ecological forestry to meet other resource objectives, including commercial harvest. The use of the term “ecological forestry” is referring to Franklin and Johnson (2012) and means that harvest retains structural and compositional elements of the pre-harvest stands, follows natural stand development principles, and applies return intervals that are consistent with disturbance regimes and that all management activities and applications are informed by landscape considerations.

The second option, described as a “context- dependent approach” by Reeves and others (2016), does not have a fixed inner width; instead, the inner width is variable and context dependent based on characteristics of the stream reach: “susceptibility to surface erosion, debris flows, thermal loading, and habitat potential for target fish species.” The second option allows for natural variation and will require more analysis to inform decision-maker choices to benefit all resources. The context-dependent approach depends on landscape considerations that are expected to occur through watershed analysis. Unlike the past, when earlier attempts at watershed analysis struggled because of lack of analytical tools (Gordon H. Reeves, Williams, Burnett, & Gallo, 2006), better tools and data are now readily available (Benda et al., 2007; (Burnett et al., 2007; Irvine et al., 2015; Isaak, Young, Nagel, Horan, & Groce, 2015; K. S. McKelvey et al., 2016). Both options proposed by Reeves and others are for second-growth stands less than 80 years old in areas designated for multiple use. Although the options were developed for the

Northwest Forest Plan Area and therefore are influenced by the conditions in that region, the underlying concepts of both options can be applied to the USFS Northern Region, including the HLC NF.

Debate remains among scientists and the public as to whether active vegetation management should occur anywhere in RMZs, even when large percentages of those zones in many areas across the West were previously managed for strictly economic purposes and no longer match distributions of conditions that would have occurred naturally. Although on the HLC NF specifically the magnitude of commercial harvest in riparian zones is minor (refer to the Timber section of the DEIS), other activities such as mining and road building have had -impacts on riparian areas in the plan area. The differing opinions between scientists makes it difficult for managers to design and implement restoration actions in RMZs (Gordon H. Reeves et al., 2016). Pollock and Beechie (2014) urge caution when considering vegetation treatments near streams because there are many trade-offs to consider, especially for some terrestrial vertebrate species that depend on large dead wood. Their study shows that emphasizing the development of large-diameter trees via thinning to create key pieces available for streams can have negative consequences for terrestrial vertebrate species. Reeves and others (2016) discuss how tree tipping can be used to offset short-term deficiencies of woody debris in small streams and adjacent riparian areas. Rieman and others (2015) suggest that it is not clear whether the considerable funding expended to date on habitat restoration treatments has been successful. Going forward, they recommend, "(1) a scientific foundation from landscape ecology and the concept of resilience, (2) broad public support, (3) governance for collaboration and integration, and (4) a capacity for learning and adaptation" (p. 124). Monitoring and adaptive management will be essential to continually learn from and refine riparian management, including on sites where only passive management occurs.

Monitoring and research reports over the past 20 years have documented the efficacy of RMZs and their ability to protect the functional attributes for riparian and aquatic resources and water quality. Using stream temperature as a response variable, a study in Oregon found no differences before and after project using a no-cut buffer as small as 25 feet (Groom, Dent, Madsen, & Fleuret, 2011). Similarly, a comprehensive study in Oregon and Washington that evaluated various buffer widths found no increases in stream temperature using a 50 feet buffer (P. D. Anderson & Poage, 2014). The study did point out that the efficacy depended on the adjacent disturbance and contrast in forest canopy. Many researchers suggest that a 30-meter buffer next to fish-bearing and perennial streams is generally likely to be sufficient to protect against temperature increase (P. D. Anderson & Poage, 2014; reeves et al., 2016; Sweeney & Newbold, 2014; Witt, Barton, Stringer, Kolka, & Cherry, 2016). Even so, considerations of context and geography are also appropriate. In a discussion of fixed-width riparian buffers, Richardson and others (2012) states that although these types of protections are administratively simple to implement at a reach scale, watershed considerations and location within the catchment provide additional important context.

Water temperature

Among the more commonly studied management concerns as they relate to ecological processes near streams and determining the appropriate widths for designating riparian management areas on the HLC NF are the effects of nearby harvest on stream temperature. Initial studies completed by Chen, Franklin, and Spies (1993) and the Forest Ecosystem Management Assessment Team (1993) found that streamside buffers of approximately 125 meters were needed to protect ecological processes such as wind speed and humidity near streams, which at the time were thought to be able to increase stream temperature. In the Pacific Northwest where Chen and others completed their studies, average site potential tree height next to streams was identified as approximately 50 meters. This finding was partially responsible for the second tree height applied to riparian reserve and riparian habitat conservation area widths in the existing strategies (Everest & Reeves, 2007; Gordon H. Reeves, Pickard, & Johnson 2013).

A study that modeled the effects of riparian reserves on stream temperature in Washington found that the first 10 meters were most important in protecting stream temperature and buffers greater than 30 meters did not appreciably lower stream temperatures (Sridhar, Sansone, LaMarche, Dubin, & Lettenmaier, 2004). A study on headwater stream microclimate by Anderson and others (2007) found that the first 10 meters had the most effect on microclimate above the stream and that temperatures in the streambed increased only when streamside vegetation closer than 50 feet was removed (P. D. Anderson & Poage, 2014). A review of studies by Moore and Wondzell (2005) suggested that a riparian reserve that was the width of one tree height was likely large enough to protect the ecological processes that control stream temperature. A subsequent study (Rykken, Chan, & Moldenke, 2007) found that stream effects helped to offset edge effects documented by Chen and others (1993). While Pollock and others (2009) did not find a correlation between recent (greater than 20 year old) streamside harvest 600 feet upstream of a monitoring site and increased stream temperature, they did find a significant relationship between basins that had greater than 25 percent harvest in the last 40 years and increased stream temperature. While the increased temperature reported (Pollock et al., 2009) was significant, it is unclear if there is a corresponding biological effect on native salmonids in the region where the studies were conducted (Gordon H. Reeves et al., 2013). For example, if a substantial rise in water temperature does not become a limiting factor in a stream reach, it may not have an effect. However, if the rise exceeds the thermal limits or growth optima of a species, negative effects would be realized.

For the past generation, many researchers suggest that a 30 meter buffer next to fish bearing and perennial streams is generally likely to be sufficient to protect against temperature increase (Gordon H. Reeves et al., 2016; Sweeney & Newbold, 2014; Witt et al., 2016). Even so, considerations of context and geography are also appropriate. In a discussion of fixed width riparian buffers, Richardson and others (2012) stated that while these types of protections are administratively simple to implement at a reach scale, watershed considerations and location within the catchment provide additional important context. While the best available science indicates there could be some flexibility for management, this strategy does not recommend changing the widths of inner and outer riparian reserves.

Water quality: sediment and nutrients

Forest management practices such as road building and harvest have long been a concern regarding their potential to generate fine sediment and subsequent effect on water quality (Robert L. Beschta, 1978). Grazing impacts are also major sediment source as cattle can effect streambank stability and streambank vegetative protection (Clary & Kinney, 2002; Clary & Webster, 1990). Altered sediment rates have also been linked to changes in stream condition and ultimately trout and salmon survival in cold water streams (Clary & Webster, 1990; Jensen, Steel, Fullerton, & Pess, 2009). Some activities that led to degraded stream conditions and water quality, i.e. clearcutting next to streams and aggressive forest road building, are highly unlikely to occur present day on NFS lands in the Northern region. Reductions in sediment and nutrient delivery have resulted from sequentially improving BMPs (Everest & Reeves, 2007) and regional strategies that have offered greater protection (USDA, 1995a). In recent decades, researchers interested in forest management and water quality have investigated the effectiveness of management policy and law (T. C. Brown, Brown, & Binkley, 1993; Cristan, Aust, Bolding, Barrett, & Munsell, 2016; Rashin, Clishe, Loch, & Bell, 2006). In general, the latest Forest BMP reviews have found very little unnatural introductions of total suspended sediments and nutrients when BMPs are properly installed before activities begin and maintained throughout management efforts (Cristan et al., 2016; Sugden et al., 2012). Increased nitrogen levels may be an exception and may still present as elevated outside of natural conditions (Gravelle, Ice, Link, & Cook, 2009). Directions carried forward from existing strategies combined with conservation and improvement strategies discussed elsewhere in this document should help to continue improving trends.

For the water resource and quality, BASI was used to inform this DEIS. The data and reports provide background information on the current and historic water quality conditions across the HLC NF. Across the planning area, water quality monitoring in conjunction with forest project activities have been occurring since the last Forest Plan was developed. The HLC NF has extensive watershed monitoring programs. For more than three decades, data have been collected at monitoring sites in timber sales and other major projects. The number of years of data collection at each site has varied based on project needs. The forest used other data including various total maximum daily loads inventory and monitoring programs, the Youth Forest Monitoring Program, and monitoring done by other governmental agencies (e.g. MT DEQ, US EPA).

Vegetation management

Managing vegetation on forest lands can impair water quality by routing runoff and sediment onto bottomland stream areas. Over the last planning period, management addressed these impacts by regulating the extent of upland timber harvest, applied BMPs to limit connection from impervious surfaces, and minimized entries into riparian habitat conservation areas to provide protection from upslope activities and filter runoff. The use of these BMPs were instituted in the 1980s to control non-point source pollution (Binkley & Brown, 1993), and the riparian habitat conservation areas were established with the INFISH amendment in 1995. Using results from State of Montana audits, the FS BMPs were effective 96 percent of the time (Ziesak, 2015). Using a similar audit scheme, the FS was 100 percent effective in establishing the correct buffer to meet the State of Montana design standards for streamside management zones (SMZs).

Forest management disturbs uplands through removal of tree canopy and the yarding of the material to a central processing facility. Site preparation historically reduced groundcover by broadcast burning remaining vegetation to bare soil for planting and clear remaining fuels. The practice in the 1980s produced higher severity fire because the purposeful clearing of vegetation also removed protective groundcover. The HLC NF has largely moved away from this practice with either mechanical piling/burning or prescribed fire as primary methods for reducing hazardous fuels. A change in contemporary timber practices to whole tree yarding has further reduced remaining vegetation while preserving protective groundcover covering at least 85 percent of the area based on soil monitoring data.

Studies have documented increased sediment erosion associated with timber harvest, but the primary agent is sediment from roads (Charles H. Luce & Black, 1999; Sugden & Woods, 2007). Management controls non-point delivery of sediment in harvest areas through the use of water and soil conservation practices and BMPs (FSH 2509.22.10, R1/R4 Amendment 1) (USDA, 2012), oriented on the stabilization of log skidding and landing networks where erosion is most probable. Otherwise, forests generally have very low erosion rates with chronic erosion after disturbance lasting typically one to three years (William J. Elliot, Hall, & Scheele, 2000). After timber harvest and site preparation, regrowth of vegetation covers the soil surface with plant litter, soils armor, and potential erosion hazard becomes low (ibid).

Where prescribed fire is applied and blackens the area, the runoff can increase from reduced infiltration. Blackened soil areas can accelerate runoff due to soil sealing from ash that lowers the infiltration capacity of soils (Doerr et al., 2006). These conditions vary spatially and decrease over the first year as products of burning in the soil degrade (ibid). Natural forest conditions have hydrophobic conditions that resist infiltration when soils dry and from plant litter waxes, but the main difference is that burned areas burned areas lack surface roughness to dissipate rain splash energy and interrupt runoff. Other factors that increase runoff from harvest and burn areas are steep slopes, low groundcover, and long slope lengths (W. J. Elliot, 2013). Runoff transports loose soil particles and deposits sediment down the slope proportional to runoff energy. One reason sedimentation decreases over time is that the sediment supply decreases after bare surfaces armor, lacking a ready sediment supply. Over the past planning period, management has

mitigated prescribed fire by not lighting fire within stream buffer areas and burning during cool and moist conditions that results in low and moderate severity fire.

The loss of forest canopy on harvest sites changes the water balance, and studies in the Pacific Northwest have documented cases where excess water from harvest areas influence peak and timing of stream flows (S. C. Anderson, Moore, McClure, Dulvy, & Cooper, 2015; Keppeler & Ziemer, 1990; Moore & Wondzell, 2005; Stednick, 1996). In reviews, these cases depended largely on the extent of harvest and climatic regime (Grant, Lewis, Swanson, Cissel, & McDonnell, 2008). The effect diminishes in time as vegetation re-establishes. Peak flow increases were raised as a concern from the potential to alter stream morphology and degrade water quality. The altering of streamflow can also influence stream temperature (Swanston, 1991), although the principle factor in affecting stream temperature is changes to riparian cover that shades streams (Robert L. Beschta et al., 1987; Gomi, Moore, & Dhakal, 2006; MacDonald & Stednick, 2003).

Watershed yield studies specifically targeted timber harvest activities that would generate a response and may not necessarily mimic current forest practices. Beschta and others (2000) found a weak relationship between forest harvest and increased peak flows, and reported “mixed messages” about the relationship between forest harvest and peak flow responses. Numerous studies documented the effects of forest canopy removal on peak flows in the Pacific Northwest (R. L. Beschta et al., 2000; Hubbart, Link, Gravelle, & Elliot, 2007; Jones & Grant, 1996; Kuras, Alila, & Weiler, 2012; R. F. Thomas & F., 1998; Tonina et al., 2008), but surprisingly, very few demonstrated a direct link between water yield/peak flow changes and measured channel impacts in forested environments. In the latest review for Pacific Northwest studies, Grant and others (2008) suggested that if degradation were to occur, channels most sensitive to peak flow changes are low gradient (less than 2%) with gravel bed and sand bed substrates.

The concern over changes to peak flow from timber harvest was raised when timber was harvested on a larger scale than current. The HLC NF no longer harvests timber at a rate seen in the 1970s to 1990s. Average annual harvest rates were 15 to 30 million board feet (23,525 acres) in the 80s compared to roughly 6 to 7 million board feet (4,397 acres) in 2012 and 2013 (see Timber section). In addition, many of the classic watershed studies could not disentangle the effects from roads where at least 2 percent of the study areas had roads and skidding network (Grant et al., 2008). Forest management has somewhat alleviated these effects by establishing streamside buffer zones (riparian habitat conservation areas with INFISH), reducing road construction and implementing best management practices.

Wetlands and groundwater

A key factor that determines wetland type and function is water regime. Water regime pertains to the depth, duration (hydro period), frequency, diurnal fluctuation, and seasonal timing of groundwater and surface water. A large suite of variables – not just water yield, peak flow, and base flow - have been used as “indicators” to describe hydrologic change in watersheds, streams, and rivers (Gao, Vogel, Kroll, Poff, & Olden, 2009; Konrad, Booth, & Burges, 2005; Merritt, Scott, Poff, Auble, & Lytle, 2010; N. L. Poff, 2009; N. Leroy Poff, Bledsoe, & Cuhaciyan, 2006; N. L. Poff & Zimmerman, 2010). A similarly large number could be used to characterize changes in wetlands.

In general terms, some indicator variables that apply to estimating the hydrologic effects of vegetation management on wetlands include:

- volume of water inputting to wetland (i.e., water yield of contributing area) and its timing
- peak water level or flow within the wetland: magnitude (depth or rate) and timing
- minimum water level or flow: magnitude (depth or rate) and timing

- percentage of days annually with surface water or measurable flow (both continuous and total)
- fluctuation (variance) in water level or flow: daily or annual
- percent of wetland water budget derived from groundwater vs. surface runoff vs. direct precipitation (and snow vs. rain)

Small isolated headwater wetlands are perhaps most at risk from hydrologic changes occurring in their catchments because their hydrologic inputs are usually the least. In glaciated landscapes, some wetlands that comprise only one-third of their catchment area can produce 50-70% of the annual streamflow, because wetlands often occur where groundwater intercepts the land surface (Verry, Brooks, Nichols, Ferris, & Sebestyen, 2011).

Vegetation management

Many but not all studies have shown that removal of trees near a stream or in a wetland causes a mean annual rise in the local water table (A. E. Brown, Zhang, McMahon, Western, & Vertessy, 2005; Grant et al., 2008; Guillemette, Plamondon, Prevost, & Levesque, 2005; Mallik & Teichert, 2009; L. B. Miller, McQueen, & Chapman, 1997; Moore & Wondzell, 2005; Scherer & Pike, 2003; Smerdon, Redding, & Beckers, 2009; Stednick, 1996, 2008; Charles A. Troendle, MacDonald, Luce, & Larsen, 2010; Winkler et al., 2010). As regeneration occurs in cutover areas, the previous rates and amounts of water transfer between uplands and wetlands return. This usually begins within 3-7 years post-harvest (R. L. Beschta et al., 2000) - less if the area has not been clearcut (R. B. Thomas & Megahan, 1998). Hydrologic recovery to pre-harvest conditions takes 10 to 20 years in some coastal watersheds but may take many decades longer in mountainous, snow-dominated catchments (Moore & Wondzell, 2005; Whitaker, Alila, Beckers, & Toews, 2002).

The probability of a harvest operation having an effect on a wetland's water regime is greatest if trees are removed directly from a wetland or, if removed from outside the wetland, the removal occurs close to and upslope from the wetland. Several other factors influence the degree to which tree removal causes water tables to rise. Especially on windy south-facing forest edges during the summer, tree roots can transfer large amounts of soil moisture to foliage and then to the atmosphere via transpiration and evaporation (Keim & Skaugset, 2003). This effectively removes some of the water before it can reach wetlands and streams. Trees also intercept significant volumes of rain and especially snow, allowing some of that retained water to evaporate before it can reach wetlands and streams located farther downslope (C. A. Troendle & King, 1987; Winkler, Spittlehouse, & Golding, 2005). Thus, when trees are removed from within or above a wetland that potential source of liquid water becomes available, the water table often rises, and the wetland may receive more water.

This has been suggested by the data from many studies of streams and watersheds in the Pacific Northwest (R. L. Beschta et al., 2000; Hetherington, 1987; Hudson, 2001; Jones & Grant, 1996; Macdonald, Beaudry, MacIsaac, & Herunter, 2003; McFarlane, 2001; R. B. Thomas & Megahan, 1998; C. A. Troendle & Reuss, 1997). If resulting increases in peak flows are great, the morphology of channels can be affected (Grant et al., 2008). This can create, expand, or shrink wetlands. Depending on the soils and topography, the slash burning and soil compaction components of some harvest operations provide additional surface runoff to wetlands, at least during a few years post-harvest (Lamontagne, Schiff, & Elgood, 2000). In addition, in snow-affected areas, clear-cuts have sometimes been shown to cause greater runoff during rain-on-snow events (Berris & Harr, 1987) and earlier peaking of streamflow (or wetland water levels).

On the other hand, harvest might measurably reduce runoff to streams and wetlands in some parts of the Pacific Northwest during low runoff periods, partly by temporarily eliminating trees that otherwise contribute water by intercepting fog (R. D. Harr, 1982; R. Dennis Harr, 1983). During the autumn,

streams in clearcut watersheds in the Pacific Northwest tend to have lower flows than in uncut watersheds (R. D. Harr, Harper, Krygier, & Hsieh, 1975). Also, cutting or windthrow of trees in or near wetlands can increase open-water evaporation sufficiently to reduce water persistence in late summer (Petrone, Silins, & Devito, 2007), especially in larger wetlands and/or in drier parts of the Pacific Northwest.

Livestock grazing

In some cases, grazing has the potential to damage springs and other types of groundwater dependent wetland habitats. These off-channel aquatic features have incredibly high biodiversity and serve important ecosystem functions. They are also attractive to livestock as they offer palatable browse and flat, cool resting spots. If not properly managed, this conflict can lead to water quality issues, damaged organic soils, and reduced wildlife habitat. Impacts to these areas are commonly noticeable earlier in the grazing season than most other types of sites within pastures. Actions in response to this use pattern has typically been to fence-off these features when damage has been repeatedly noted. This is effective as long as fences can be consistently maintained. Maintenance failure can result in higher levels of damage as cattle may remain there longer as they move further away from the point of entry, limiting access to outside the exclosure. Adaptive management has been implemented in some areas to resolve localized issues.

Riparian dependent terrestrial species

BASI, since the Strategies were published, has sharpened focus on aquatic/riparian interactions. One review found that buffers wider than 30 meters are large enough to protect water quality and aquatic biota in small streams (Sweeney & Newbold, 2014). In some circumstances such as a narrow band of riparian dependent vegetation alongside an intermittent stream that has low connectivity, these characteristics could lead to a reduced width for the riparian management zone if only aquatic functions are being considered. However, RMZs have had increasing focus applied to their ability to support terrestrial organisms and processes. Starting as far back as the Forest Ecosystem Management Team (1993), “Protection of riparian-associated terrestrial organisms has become an explicit conservation objective associated with protection of streams (Richardson et al., 2012).” Numerous studies have published research on riparian use by species from invertebrates (Bunnell & Houde, 2010) to amphibians (Olson & Burton, 2014) and from mammals (Kevin S. McKelvey & Buotte, in press; Wilk, Raphael, Nations, & Ricklefs, 2010) to avifauna (Lehmkuhl et al., 2007; Marcot et al. 2016).

Science published on wildlife use of the riparian area is more varied and subsequently more complicated. In a literature review considering appropriate widths for RMZs, Wenger (1999) found that buffer distances reported to protect terrestrial wildlife ranged from as little a few feet to over 1000 feet. A distance of 300 feet was recommended for most wildlife acknowledging that the distance might be difficult to implement in all management applications. Lee and others (2004) completed a literature review of management prescriptions next to water bodies in both Canada and the U.S. They found that while prescriptions for buffer widths varied by water type such as wetlands, intermittent streams, and fish bearing streams, they were generally wide enough to protect many of the important riparian processes that support aquatic biota. However, buffers were generally less than recommended widths to protect terrestrial fauna. Marczak and others (2010) found that for buffers less than 50m wide, responses by different taxa became more variable as compared to untreated riparian areas. They also found that taxa did not respond similarly to riparian treatments; edge related species increased in abundance or diversity while some interior associated species declined. Some species presence and abundance remained unchanged. Ultimately, they found that current buffers do not retain terrestrial fauna at levels comparable to unmanaged sites for all taxa. They offered that sometimes upland terrestrial vegetation might need to be combined with the protections that come with RMZs for some sensitive terrestrial species (Semlitsch and Bodie, 2003). They concluded that increases in protections in some locations should be balanced with some riparian areas allowing partial resource extraction (Marczak et al., 2010; reeves et al., 2016).

Riparian ecosystems are equally important habitat to wildlife for feeding, drinking, cover, breeding season habitat, and habitat connectivity. They are often rich in bear foods such as skunk cabbage and other herbaceous plants with nutritious bulbs. Many wildlife species are associated with riparian ecological systems, including beaver, Canada lynx, grizzly bear, harlequin ducks, and mink. Upland vegetation within riparian areas in combination with the riparian vegetation create zones that provide important wildlife habitat and connectivity values. Most wildlife use RMZs and/or aquatic habitats for at least some of their daily or seasonal needs. Due to their widespread distribution and linear or clustered pattern, they provide extensive and important habitat connectivity areas for numerous species of wildlife. Refer to wildlife section for information on riparian associated wildlife species and habitat connectivity.

During the past few decades, land managers have recognized the importance of riparian ecosystems in maintaining water quality, terrestrial, and aquatic habitat. As a result, riparian conservation measures have been developed for federal, state, and private lands – helping to preserve and protect the integrity of the riparian and wetland habitats, as well as the water quality of associated waterbodies.

Fisheries and other aquatic species

Around the beginning of the 20th century, the influx of human populations began along with the development of the land and resources to support those populations. This has resulted in many new human-caused disturbances to the watershed systems, and the pattern of many of those disturbances has tended to be a more sustained or “press” disturbance regime. A press disturbance forces an ecosystem to a different domain or set of conditions (G. H. Reeves, Benda, Burnett, Bisson, & Sedell, 1995). Many of those disturbances tend to mimic historic “natural” processes (i.e. livestock grazing and American Bison), but the frequency and intensity has been greatly amplified. In some cases, the watershed systems have begun to adjust to those press disturbances; or have become altered by them, resulting in an inability to support aquatic dependent resources.

Stream habitat degradation in the western U.S. became a great concern in the early 1990s, as well as the potential the loss of salmon, trout, and char populations (Nehlsen et al., 1991; Rieman & McIntyre, 1993). By the mid 1990’s, The FS and BLM completed three broad reaching documents that amended forest plans across much of public lands in the west to improve their conservation function. Two of those documents were: *Record of Decision for Amendments to Forest Service and Bureau of Land Management Land Planning Documents Within the Range of the Northern Spotted Owl* (often referred to as Northwest Forest Plan Record of Decision, 1994); and the *Decision Notice/Decision Record for Interim Strategies for Managing Anadromous Fish-Producing Watersheds on Federal Lands in Eastern Oregon and Washington, Idaho and Portions of California* (USDA, 1995a). Both of these documents greatly improved protection for migratory salmon and steelhead. These documents influenced the development of the last of the three broad strategies developed, which was the *Inland Native Fish Strategy-Interim Strategies* (INFISH) *for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada* (USDA, 1995b). While INFISH was originally expected to last 18 months to three years while an effort similar to the Northwest Forest Plan, the Interior Columbia Basin Ecosystem Management Project (Frissell et al., 2014), was completed for the Interior Columbia River Basin. That strategy was never completed, but science from that effort has been retained in the form of guidance for plan revisions occurring in areas covered by INFISH and PACFISH. Interior Columbia Basin Ecosystem Management Project science and guidance is followed in this plan revision.

INFISH was designed to maintain options for inland native fish by reducing negative impacts to aquatic habitat. Riparian management objectives, standards and guides, and monitoring requirements were implemented beginning in 1995 to avoid causing further damage and begin recovery of aquatic habitats. The 1986 Helena NF Plan was amended by INFISH in 1996. This strategy is still in effect west of the

continental divide on portions of the Divide and all of the Upper Blackfoot GAs of the HLC NF. The INFISH strategy does not apply to those GAs of the HLC NF east of the continental divide.

Since INFISH was implemented, there have been numerous changes to policy, BASI, and the condition of listed species. There have been tremendous advances in knowledge regarding physical habitat and ecological interactions at many scales and across scientific disciplines, as well as advances in spatial data-base management. Scientists findings disclosed in BASI urge managers and biologists working to maintain and improve aquatic habitat to look beyond just the stream reach when considering how best to plan and implement project activities. Climate change science has also emerged as an important aspect of forest and river management since INFISH was adopted.

When instituted, riparian management objectives were considered by many to be an important component of INFISH. Riparian management objectives were developed from PACFISH objectives measured in habitats across the range of anadromous fish in Washington, Oregon, and Idaho. The objectives selected were considered good indicators of ecosystem health, and were thought to be, “a good starting point to describe the desired condition for fish habitat.”(INFISH, p. E-3, 1995- emphasis added). INFISH guidance recommended that riparian management objective values should “be refined to better represent conditions that are attainable in a specific watershed or stream reach based upon local geology, topography, climate and potential vegetation” (USDA, 1995b). Since INFISH was adopted on the Helena NF west of the continental divide, data has been collected and used for comparison purposes in project design, consultation, and monitoring. As indicated in INFISH, the riparian management objectives of pool frequency, width/depth ratio, and supporting feature water temperature categories are applicable to all systems, and large woody debris to forested systems, while bank stability and lower bank angle may apply more to non-forested habitat areas of the HLC NF where specific land uses may affect these habitat features. INFISH did not provide any sediment indicators as riparian management objectives.

Several factors have contributed to the decline of bull trout. Habitat degradation, interaction with exotic species, over harvesting, and fragmentation of habitat by dams and diversions, are all factors contributing to the decline (Rieman & McIntyre, 1995). Historically, bull trout populations were distributed throughout the Core Areas and in larger tributaries and were in higher densities than they are today.

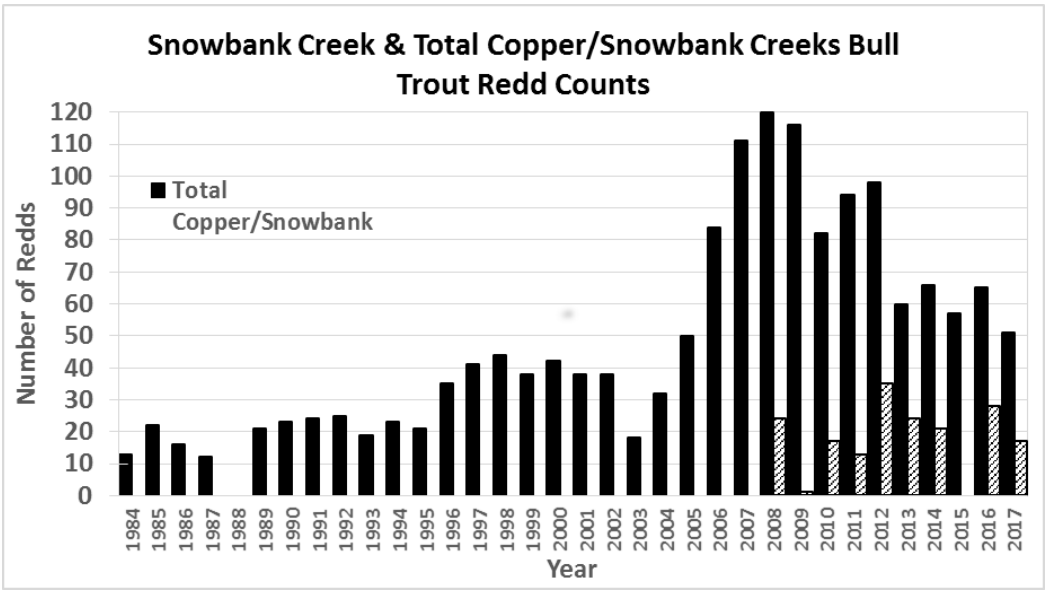
Substantial impacts to the population were likely related to water rights and water diversions, overgrazing, and clearing stream riparian areas. Use of surface waters required diversions, which were not usually screened, led to the entrainment of various age classes of aquatic species. In addition to unscreened diversions, the withdrawal of water from the stream diminished the ability to provide adequate habitat for aquatic species. Clearing of riparian shrubs and damage to streambanks by over-grazing also caused impacts to stream's geomorphology making them wider and warmer. Eroding banks introduced higher amounts of sediment than could be transported by the streams, which exacerbated stream morphology problems and reduced fish spawning success. Significant timber harvest and road building was also taking place. These activities led to additional increases in fish barriers following the installation of undersized culverts. These barriers resulted in increasing sediment delivery and stream temperatures, as well as other water quality impacts. Many of these impacts have been reduced or eliminated, decreasing some stressors on the population so they no longer play as large a role as they historically did. For instance, fish barriers have been identified as a significant impact and multiple agencies and partners have engaged in removing or upgrading culverts. Also, connectivity has been improved by removing or mitigating local barriers such as irrigation diversion structures on and off forest lands to provide fish passage.

Bull trout spawning occurs in the fall, and the eggs incubate in the stream gravel until hatching in January (Fraley & Shepard, 1989). The alevins remain in the gravel for several more months and emerge as fry in early spring. Unlike many anadromous salmonids, which spawn once and die, bull trout are capable of

multi-year spawning (ibid). The historic range of bull trout stretched from California, where the species is now extinct, to the Yukon Territory of Canada (Haas & McPhail, 1991).

Bull trout populations in the Little Blackfoot drainage currently appear to be resident populations. The population trend for spawning bull trout in the primary spawning tributaries (Blackfoot Core Area, Copper and Snowbank Creeks) on the HLC NF shows an overall increasing trend between 1984 and 2017. Total redd counts in the two streams showed the highest numbers counts in 2008 and have decreased since then but still remain above 1984-2005 levels. A critical issue with this monitoring data is the short time scale. In addition to the Index Section initiated in 1984, observations of substantial spawning occurring upstream led to adding the Upper Section on Copper Creek in 1996. Following work that re-connected Snowbank and Copper creeks, a redd count section was established on Snowbank Creek in 2008. Furthermore, the additional downstream section of Copper Creek on NFS lands has been examined to determine if spawning habitat is present. The trends in the number of redds over the past 32 years shows an increase following the 2003 Snow-Talon Fire in the Copper/Snowbank Creeks drainage (Figure 1). As funding allows, the Forest expects to continue to collaborate with MTDFWP and USFWS on completing bull trout redd count surveys.

Figure 1. Total Snowbank and Copper Creeks bull trout redd counts 1984-2017



Historically, bull trout numbers were likely at much higher levels and we assume that the population is still well below its potential. Currently, the main factor limiting recovery of bull trout in the Blackfoot is thought to be the lack of high quality tributaries throughout the watershed (USDA-USFWS, 2013). However, it is unlikely that this impact is entirely responsible for the overall decline. Numerous other impacts have contributed to the decline, including inadvertent angling-related mortality, warming water temperatures, anthropogenic sediment delivery, non-native fish competition and hybridization. Future concerns are anticipated to be associated with the protection of instream flows in an era of increasing human consumption of surface and groundwater since these factors can have profound effects on the habitat requirements of bull trout and connectivity for the migratory fluvial form.

Aquatic invasive species

Nonnative invasive species are a serious threat to all aquatic habitats in the U.S. The severity of this threat is difficult to assess or predict in this plan area, or in any other specific locality. Virtually every biological lifeform has been a documented agent in disruptive outbreaks in North America. These lifeforms cover

the range from viruses to mammals. Included in documented losses to ecologic integrity and beneficial uses are vegetative lifeforms that range from single-cell algae to vascular plants such as nonnative trees.

The ecological and economic impacts of invasions vary greatly in scale. Effects from invasive species also vary with local environmental dynamics and complexity of the ecosystem. For example, whirling disease (*Myxobolus cerebralis*) appears to have produced major changes in the assemblage of fish species in some Montana rivers but not in others. Where ecological disruptions have been noted, there were lost recreational opportunities and revenues for the tourism, outfitting, and related industries. The intensity of effects has been less pervasive, suggesting the conditions and habitat to complete the life cycle requiring two hosts have proven to date to be less suitable than in other waters and/or resistance exists in the salmonid populations.

When a new aquatic invasive species invasion occurs in a locality, it often requires research and observation time before reliable inferences can be made regarding spread patterns, specific effects, and potential containment strategies. A baseline often is lacking to predict how an invasive species from another region or continent will respond when introduced into a new environment. Since a local environment contains a unique assemblage of thousands of interconnected components and processes, the results in one area can vary slightly or significantly from previously infected areas.

Prevention of invasions is of paramount importance in land and natural resource management. If an aquatic invasive species becomes established, elimination may be nearly impossible and efforts for containment can be very difficult, time consuming, and expensive. This involves recognizing the vectors for infection and spread and implementing safeguards, or resource protection measures, to minimize and prevent the transmission of invasive organisms through these pathways. An example of a transmission vector would be heavy equipment, pumps or mineral exploration equipment that come into contact with water. This equipment can be highly mobile from drainage to drainage with some exploration equipment even transported globally between projects, allowing microbes, spores, planktonic larval and adult stages, and plant materials to be easily be spread. Effective sanitation and inspection measures are essential resource protection measures.

Spread and introduction vectors are inherent to most projects and types of forest use. Thus, components of the Draft Plan require mechanisms for addressing aquatic invasive species. More general or universal objectives and procedures, such as using current BMPs for equipment washing before and after entering an area, are recommended for inclusion. High risk activities within individual resource areas are likely best addressed in resource-specific sections. This better assures that these components are included as resource protection measures at the project level. These activities would include, but aren't limited to; transporting water across drainage boundaries for fire suppression, constructing stream fords, operating equipment in a riparian area and near a water course, and the use of pumps and sumps for mineral exploration, fire suppression, or construction related dewatering activities.

Conservation watershed network

The BASI indicates the HLC NF is and will be important for conservation of native bull and westslope cutthroat trout within their range. The planning area is located along both sides of the continental divide and it is predicted the planning area would provide cold water refugia into the future due to the effects of climate change being slower in high elevation mountain streams.

Climate shield and temperature models across level 6th hydrologic unit codes in the plan area looked closely at where cold water is predicted to persist into the future in the face of climate change. The models identified that cold water is predicted to persist in the sub-watershed in the Blackfoot GA that was identified as a priority watershed under INFISH. HLC NF priority bull trout and westslope cutthroat trout

occupied watersheds and designated critical habitat by the USFWS are included in the HLC NF conservation watershed network. Isaak and others(2015) identified bull trout and westslope cutthroat trout probabilities of persistence into the future under different climate warming scenarios as well as cold water refugia. The Climate Shield Model (Isaak et al., 2015) was used as a starting point to identify watershed with cold water that may persist into the future.

At the broadest of scale considerations, information in USFWS bull trout recovery plan was reviewed to help place habitat and core populations located within the HLC NF in context with recovery needs of the species across its range in the western U.S. For recovery units like the Columbia Headwaters, the plan strategy states, “A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the breadth of the genetic makeup of the species to conserve its adaptive capabilities); resilience (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events).”

Soils

Overview

Soil monitoring data on the HLC NF have demonstrated that allowing ground based equipment only on slopes below 35 % maintains the level of detrimental soil disturbance below the regional threshold (USDA, 2012-2017).

Coarse wood debris in the form of slash can provide a practical and effective mitigation for reducing harvest impacts on soil physical function and processes ((R. T. Graham et al., 1994; Harvey, Jurgensen, & Graham, 1989). Leaving harvest slash along skid trails can prevent compaction (Han, Han, Page-Dumroese, & Johnson, 2009) and enhance soil recovery (D. S. Page-Dumroese, Jurgensen, & Terry, 2010). Coarse wood debris contains very little nutrient value (Laiho & Prescott, 1999), but its function as groundcover and tempering soil climate promotes soil biologic activity. Target coarse wood levels balance needs for fuels reduction, soil production and wildlife. Optimal ranges for Montana and Idaho forests were reported as 5 to 20 tons per acre for warm sites and 10 to 30 tons per acre for cooler sites (J. K. Brown, Reinhardt, & Kramer, 2003). Any benefits from road decommissioning will depend largely on site potential for recovery (Switalski, Bissonette, DeLuca, Luce, & Madej, 2004). Road treatments will stabilize the surface from erosion, while soil biology, soil chemical and hydrologic properties slowly recover as plants recolonize. Lloyd and others (2013) quantified road recovery on the Nez Perce – Clearwater NF, showing faster soil recovery for treated roads where the road prism was outsloped along with some level of revegetation versus abandoned roads. It was found that topsoil developed on treated roads more readily than topsoil on roads abandoned for nearly thirty years.

Adequate canopy and groundcover is the best protection against soil erosion. Overland flow and surface erosion are rare in Rocky Mountain forests (Wondzell & King, 2003). Based on the disturbed Water Erosion Prediction Project model, a soil erosion model amended for forested environments, soil erosion rarely occurs if groundcover exceeds 85% cover (William J. Elliot, Page-Dumroese, & Robichaud, 1999).

The steep topography of the HLC NF naturally predisposes slopes to erosion after wildfires. Erosion caused by intense rainfall following these fires will continue as a natural geomorphology agent as it has occurred episodically in Rocky Mountain forests for millennium (Kirchner et al., 2001; D. Miller, Luce, & Benda, 2003). When taking a closer look over a century scale, fire incidence coincides with warm phases of the Pacific Decadal Oscillation (Morgan, Heyerdahl, & Gibson, 2008). This latest warm cycle has continued with periods of dry springs and hot summers. These conditions align with large scale fire patterns based on tree-ring research (Gray & McCabe, 2010; Madany, Swetnam, & West, 1982). Climate

change predictions suggest a continued increase in monthly temperatures along with longer periods of drought that increase the wildfire hazard.

In regards to prescribed burning and wildfires, across blackened areas, the net effect of the burn residue and surface sealing of soil pores can exacerbate erosion potential by slowing infiltration (Larsen et al., 2009; Wondzell & King, 2003). This post burn condition is highly variable spatially and decreases over time (Doerr et al., 2006). One benefit of fuels treatments is that it re-introduces fire into the system. Burning creates a net increase in available nutrients, both in terms of the products of fire contained in ash residue and the higher decomposition rates after the fire. Almost immediately, burning increases the amount of available nitrogen for plants and soil biota (Choromanska & DeLuca, 2002; Hart, DeLuca, Newman, MacKenzie, & Boyle, 2005). In drier habitats, this increase can be detected as much as 50 years after a fire event (McKenzie, Gedalof, Peterson, & Mote, 2004). The burning also produces charcoal production that enhances conditions soil by increasing water holding capacity and providing exchange sites (DeLuca & Aplet, 2008).

Ability of soil to maintain ecological functions

FSM Chapter 2550 Soil Management identifies six soil functions: soil biology, soil hydrology, nutrient cycling, carbon storage, soil stability and support, and filtering and buffering. Soil is the foundation of the ecosystem; in order to provide multiple uses and ecosystem services in perpetuity, these soil functions need to be active.

The soil biology attributes of note on the Forests are roots and aeration, plant community potential, and thermodynamics. Little information currently exists on the trends of soil biology. It is likely that severe or frequent burns (natural or prescribed) reduce the diversity of the soil biota by reducing the soil organic matter required to support the biota. Similarly, erosion may reduce soil biota diversity. Climate change will likely change the soil biota due to increased accumulation and decomposition of organic matter and changes in soil temperature and moisture. The climate change effects are site specific. Invasive species cover may also reduce soil biota diversity.

Soil hydrology is the ability of the soil to absorb, store, and transmit water both vertically and horizontally. Soil hydrology is extremely important on the Forests because the ecosystem productivity is typically limited by water. Soil can regulate the drainage, flow, and storage of water and solutes, including nitrogen, phosphorus, pesticides and other nutrients and compounds dissolved in water. When properly functioning, soil partitions water for groundwater recharge and use by plants and animals. Changes in soil bulk density, soil chemistry, soil structure, soil pores, and ground cover can alter soil hydrology. The main impacts to soil hydrology on the Forests are compaction, erosion, loss of vegetation cover, and hydrophobicity from severe burns. Interception by roads also affects soil hydrology. The historic soil impacts from past activities have affected soil hydrology especially in areas where road densities are high.

Nutrient cycling is the movement and exchange of organic and inorganic matter back into the production of living matter. Soil stores, moderates the release of, and cycles nutrients and other elements. During these biogeochemical processes, analogous to the water cycle, nutrients can be transformed into plant available forms, held in the soil, or even lost to the atmosphere or water bodies. Soil is the major ‘switching yard’ for the global cycles or carbon, water, and nutrients. Carbon, nitrogen, phosphorus, and many other nutrients are stored, transformed, and cycled through the soil. Decomposition by soil organisms is at the center of the transformation and cycling of nutrients through the environment. Decomposition liberates carbon and nutrients from the complex material making up life forms and puts them back into biological circulation so they are available to plants and other organisms. Decomposition also degrades compounds in soil that would be pollutants if they entered ground or surface water. Nutrient

cycling can be assessed by considering organic matter composition on a site and the nutrient availability. The major impacts to nutrient cycling are compaction and loss of organic matter and topsoil.

Nearly all nitrogen in forest systems is bound to organic matter. Very little of the total pool of nitrogen is available to plants; only about 2.5 percent of total organic nitrogen is released annually (Grigal & Vance, 2000). The rate of nitrogen release from organic matter (a process called mineralization) is controlled by microbial decomposition, which in turn is controlled by environmental factors as well as the amount and chemical composition of organic matter (Drury, Voroney, & Beauchamp, 1991; Grigal & Vance, 2000). Rates of mineralization are highly spatially variable within stands (Campbell & Gower, 2000). The availability of nitrogen from organic matter has been said to 'most often limit the productivity of temperate forests' (Hassett & Zak, 2005). Logging residues are a source of nitrogen during early periods of stand growth after harvest (Hyvonen, Olsson, Lundkvist, & Staaf, 2000; Malkonen, 1976). Dead woody material left after logging provides carbon-rich material for microbes to feed upon; and typically microbial populations increase after forest harvests due to the input of logging residues. When logging residue is removed for fuels management and/or site prep microbial populations may decrease.

Carbon storage is the ability of the soil to store carbon. The carbon cycle illustrates the role of soil in cycling nutrients through the environment. More carbon is stored in soil than in the atmosphere and above-ground biomass combined. Compaction and loss of organic matter and topsoil can be assumed to affect carbon storage.

Soil structure and support gives soil the ability to maintain its porous structure to allow passage of air and water, withstand erosive forces, and provide a medium for plant roots. Soils also provide anchoring support for human structures and protect archeological treasures. Soil support is necessary to anchor plants and buildings. Both flexible (it can be dug) and stable (it can withstand wind and water erosion), soil also provides valuable long-term storage options including protecting archeological treasures and land-filling human garbage. The need for structural support can conflict with other soil uses. For example, soil compaction may be desirable under roads and houses, but can be devastating for the plants growing nearby.

Soil acts as a filter to protect the quality of water, air, and other resources. Toxic compounds or excess nutrients can be degraded or otherwise made unavailable to plants and animals. The minerals and microbes in soil are responsible for filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic materials, including industrial and municipal by-products and atmospheric deposits. Soil absorbs contaminants from both water and air. Some of these compounds are degraded by microorganisms in the soil. Others are held safely in place in the soil, preventing contamination of air and water. When the soil system is overloaded, such as with the excess application of fertilizer or manure, or when the soil is unstable, some contaminants will be released back to the air and water through erosion or leaching.

Soil impairments and disturbances

Land-use and forest practices have affected soil functions, and these functions are intertwined, making it difficult to discuss them separately. Management action such as timber activities, livestock grazing, road management, fuels management, and recreation can all have effects such as compaction, erosion, and loss of organic matter, and can impair the majority of soil functions. While these effects have not been eliminated in current practices, the FS has decreased these types of effects. This reduction, coupled with soil restoration activities, should result in a sustainable or possibly even increased capacity of the soils to support multiple uses and ecosystem services.

Harvesting timber requires machinery to cut and yard trees to landings sites that can compact and displace soils (Cambi, Certini, Neri, & Marchi, 2015; D. S. Page-Dumroese, M. F. Jurgensen, et al., 2010). Intensity and extent of impacts are managed by project mitigation and best management practices. Using soil monitoring, the FS evaluates the efficacy of forest treatments by comparing disturbance extent against soil quality thresholds. When soil disturbance surpasses these thresholds then long term impairment could occur and the disturbance is considered detrimental to soil quality. Soil surveys have found ground based harvest and skidding methods have resulted in the highest disturbance levels (USDA, 2012-2017). Contemporary methods have reduced impacts with lower pressure, wider track or tread equipment, although economics and advances in mechanization have driven operators to favor ground based equipment. Forest monitoring has not found forest treatment intensity to equate to disturbance, because skid trails are a far greater disturbance factor than the degree of tree removal. Soil compaction largely occurs after only three passes by equipment and most pronounced on skid trails (Han et al., 2009; Williamson & Neilsen, 2000). Because the same skid trail networks are used for both thinning and regeneration type harvests they have near equal rates of soil disturbance (Milner, 2015).

Fire impacts soils by consuming organic matter and producing surface conditions prone to soil erosion. The impact is described qualitatively as soil burn severity which conveys the magnitude of energy released from the consumption of fuels and the duration of heating. When fires burn all the above ground biomass and forest floor, a large portion of the nutrient supply is volatized into the atmosphere (Erickson & White, 2008; Neary, Klopatek, DeBano, & Ffolliott, 1999). The inherent soil quality may remain intact after wildfire since wind driven fire rarely heats deep into soil (Hartford & Frandsen, 1992). However, after the wildfire, the lack of forest canopy and bare soil creates conditions suitable for erosion. Water and wind erosion transport and deposit soil material incrementally downslope until slopes stabilize. Erosion is highest where fires burn severely on steep hillsides. Though natural, recovery in these areas depends on available moisture and recolonization from neighboring vegetation and soil patches.

The potential impacts of anthropogenic climate change on the forest soil resource are not well known at this time. Warmer, more moist winters may result in large areas of reduced capability for winter harvest operations; a common soil protection practice on the HLC NF. Increased frequency and severity of summer droughts could threaten effective vegetation cover through increased wildfire, and pathogen and insect activity. Literature suggests that opportunities may exist to manage the soil carbon pool (Harmon & Marks, 2002; Johnson & Curtis, 2001). However, predicted soil carbon response to anthropogenic climate change is extremely uncertain at this time (Friedlingstein et al., 2006; Todd-Brown et al., 2013).

Soil has the ability to either store or release greenhouse gases; thereby, potentially influencing climate change. More carbon is stored in soil than in the atmosphere and above-ground biomass combined (Yanai, Currie, & Goodale, 2003). Soil carbon is in the form of organic compounds created through photosynthesis in which plants convert atmospheric carbon dioxide into organic carbon compounds. The organic compounds enter the soil system when plants and animals die. Immediately, soil organisms begin consuming the organic matter, releasing water, heat, and carbon dioxide back to the atmosphere. Thus, if no new plant residue is added to the soil, soil organic matter will gradually disappear. If plant residue is added to the soil at a faster rate than soil organisms convert it to carbon dioxide, carbon will gradually be removed from the atmosphere and stored (sequestered) in the soil. Some forms of soil carbon are very stable and will persist for long periods. It is unknown at this time as to how forest practices affect soil carbon storage, although research is on-going.

Current findings from the FS Long Term Soil productivity study suggest that the extent of impacts to soil relate to texture and organic matter (D. Page-Dumroese, D. Neary, & C. Trettin, 2010; Powers et al., 2005) but often as confounding variables. For example coarse textured soils appear resistant to compaction (Gomez, Powers, Singer, & Horwath, 2002), but also nutrient poor and at risk to the

nominally least risky treatments that remove forest floor (D. Page-Dumroese et al., 2006; D. S. Page-Dumroese, D. Neary, & C. Trettin, Eds., 2010). Forestry research has underscored the importance of organic matter documenting the soil benefits of downed wood (Russell T. Graham et al., 1994; Harvey et al., 1989), forest floor and soil organic matter (Jurgensen et al., 1997). The Rocky Mountain Research Station has responded by initiating studies to establish minimal necessary amounts of organic matter by habitat type. The forest floor can act as a mulch and buffers the soil microclimate to hold water on warmer, less moist sites for soil and plant processing in addition to providing a nutrient cache. Colder, moist sites would not have the same water issues and thus adequate forest floor can be less constraining for growth.

Future climate and fire influences on aquatic ecosystems

Over the last 50 years, average spring snowpack (April 1 snow water equivalent) has declined and average snowmelt runoff is occurring on average 15 days earlier in the spring where expected future changes could be as much as 20 to 40 days earlier in many streams (Stewart, Cayan, & Dettinger, 2004). These trends are observed for northwestern Montana, the entire Pacific Northwest, and much of the western U.S. Several recent studies of the same trends across the entire western U.S. have concluded that natural variability explains some, but not all, of the west-wide trend in decreasing spring snowpack and earlier snowmelt runoff.

Shifts in climate could play out mostly in mid elevation forests where winter moisture comes as rain rather than snow, and where a decrease in snowpack could result in prolonged periods of soil moisture deficit. It is likely this would continue the trend of earlier spring, as much as two months over the next century (Charles H. Luce, in press).

A decrease of snowpack could extend soil drought to the mid elevations that is now common to low elevation ponderosa pine forests. The seasonal water deficits could stress mesic species such as lodgepole and sub-alpine fir that make up the mixed conifer forests. It is possible drought stress would affect mid elevation forests even more because forest species shift will occur according to aspect in this zone. Concave slope areas would grow mesic species since these areas have moist deep soils from converging slope water. The upper extent of the timber line would likely move up in elevation as the growing season extends in these normally cold limited environments.

Impacts to streams and riparian areas

Fire and changing conditions on the landscape that result from a warming climate must be kept in mind when considering riparian management needs (Dwire, Meyer, Riegel, & Burton, 2016; Joyce, Talbert, Sharp, Morissette, & Stevenson, in press; C. Luce et al., 2012; Gordon H. Reeves et al., 2016). When considered by subregion, model runs in the Northern Region show that averaged temperatures would continue to become warmer during the first half of the 21st century (Joyce et al., in press). Some locations in the region are expected to become drier and have more periods of drought; while overall, precipitation is expected to range from 5% less to an increase of up to 25%, with a mean increase expected to be 6 to 8% (ibid). Climate is expected to reduce stream flows (C. H. Luce & Holden, 2009), reduce the storage capacity associated with snowpack (Luce et al., 2014), and shift the timing of run-off in some locations (C. Luce et al., 2012; C. Luce et al., 2014).

Climactic changes are expected to differentially effect tree species and their distribution on the landscape, as well as some of the pathogens that act upon them (Keane et al., in press). There is also significant concern that climate change effects combined with altered disturbance regimes caused by fire suppression would change ecosystems (Hessburg, Agee, & Franklin, 2005; C. Luce et al., 2012). Finally, climate change may create conditions heretofore not observed and cause ecosystems to shift in novel ways (C.

Luce et al., 2012; Gordon H. Reeves et al., 2016). These changes include how riparian areas respond to potentially novel disturbance regimes (Dwire et al., 2016; Hessburg et al., 2015; reeves et al., 2016). How land managers prepare and respond becomes ever more crucial.

The relation of fire behavior between riparian areas and adjacent uplands is influenced by a variety of factors, contributing to high spatial variation in fire effects to riparian areas. Landform features, including broad valley bottoms and headwalls, appear to act as fire refugia (Camp et al., 1997). Biophysical processes within a riparian area, such as climate regime, vegetation composition, and fuel accumulation are often distinct from upland conditions (Dwire & Kauffman, 2003). This can be especially true for understory conditions (Halofsky & Hibbs, 2008). Riparian areas experiencing moderate annual climate conditions can have higher humidity and can act as a buffer against fire and therefore as a refuge for fire-sensitive species (ibid). Some studies have found fire typically occurs less frequently in riparian areas (Dwire et al., 2016; Russell & Mcbride, 2001).

Depending on geologic and topographic features, riparian conditions and response to fire vary (Halofsky & Hibbs, 2008). A study in mixed severity conifer stands in the Sierra Nevada found that riparian and upland conditions are similar and consequently fire effects are similar (Van de Water & North, 2010). Under severe fire weather conditions and high fuel accumulation, riparian zones may become corridors for fire movement (Pettit & Naiman, 2007). Fire effects occurring upstream will likely influence downstream conditions (Wipfli et al., 2007), as well as future fire behavior (Pettit & Naiman, 2007). Effects of high severity fire on aquatic systems will likely have short term negative affects at the reach scale but beneficial effects over time at that same scale as recolonization naturally occurs (Gresswell, 1999). At a watershed scale, fire effects for one life history phase can be negative, while in the same watershed, the fire effects will be beneficial for another life history phase (Flitcroft et al., 2016). Considering these varied conditions that occur from the stream edge to upslope and from river mouth to mountaintop, riparian response to fire is complex and heterogeneous and therefore requires considerate effort to design treatment plans that maximize benefits for both terrestrial and aquatic dependent species.

Restoration treatments in riparian areas

In the face of larger fires and disease outbreaks, the challenge of how to integrate management of aquatic and terrestrial resources has now confronted the agency for over a generation, including the Northern Region. Rieman and others spoke directly to this perception and identified opportunities for convergence. (Rieman, Lee, Thurow, Hessburg, & Sedell, 2000), as have many others since (Hessburg et al., 2015; Gordon H. Reeves et al., 2016; reeves et al., 2016; Rieman, Hessburg, Luce, & Dare, 2010). Current habitat has been degraded in many dry and mesic forests, and treatments (such as road improvement or relocation, culvert replacement, thinning, prescribed fire and wildfire use to restore old forest structure) could create more suitable aquatic habitat in the long term. Rieman and others stated, “By working strategically it may be possible to establish mosaics of fuel and forest conditions that reduce the landscape risk of extremely large or simultaneous fires without intensive treatment of every subwatershed (Rieman et al., 2000).” Further, they suggested recovery of function in some watersheds may not be possible without some human intervention.

Dry forest treatments, while still controversial (Williams & Baker, 2012), are broadly supported by current scientific literature (Hessburg et al., 2016) and have continued to gain acceptance from the public and greater use by managers. In the Northern Region of the FS, restoring mixed severity fire regimes also remains controversial and complicated for numerous reasons such as the habitat needs of ESA listed species like steelhead, bull trout, lynx and grizzly bear. Treating riparian areas in mixed severity forests can be especially controversial and complicated. In locations where up-slopes and riparian forests have qualitatively similar fire effects, treatments guided by scientific findings are likely to restore ecological function of fire regimes at the landscape level (Finney et al., 2007). Position in the landscape relative to

elevation, location within the stream network, and climate regime should be carefully considered to ensure understanding of riparian function (Gordon H. Reeves et al., 2016; reeves et al., 2016) Pettit & Naiman, 2007). Because the effects of restoration treatments on departed riparian habitats are poorly understood, focused research in an adaptive management framework will be necessary.

In addition to vegetation treatments in riparian areas, stream channel restoration treatments will likely be considered to help aquatic ecosystems adapt to climate change. In a paper titled "*Restoring Salmon Habitat for a Changing Climate*" (Beechie et al., 2013), the authors recommend actions that connect streams to floodplains, restore flow, and help degraded channels aggrade as actions most likely to improve water temperatures. They also disclose that instream channel actions are unlikely to ameliorate climate change effects entirely.

Impacts to fisheries and other aquatic species

Expected climatic and hydrologic trends, combined with climate-related trends in wildfires and forest mortality from insects and diseases, can significantly affect aquatic ecosystems and species (J. Dunham, Rieman, & Chandler, 2003; J. B. Dunham, Rosenberger, Luce, & Rieman, 2007; Isaak et al., 2010). A growing body of literature has linked these hydrologic trends with impacts to aquatic ecosystems and species in western North America, often as a result of climate-related factors affecting stream temperatures and the distribution of thermally suitable habitat (Bartholow, 2005; Isaak et al., 2010; Kaushal et al., 2010; Morrison, Quick, & Foreman, 2002; Petersen & Kitchell, 2001). Lower summer stream flows and higher air temperatures, as observed over recent decades in Montana, are generally expected to result in increased stream temperatures. However, stream temperatures are controlled by a complex set of site-specific variables; including shading from riparian vegetation, wind velocity, relative humidity, geomorphic factors, groundwater inflow, and hyporheic flow (Caissie, 2006).

Potential changes in streamflow and rising stream temperatures are likely to increase risks to maintaining existing populations of native, cold-water aquatic species. Over the last century, most native fish and amphibians have declined in abundance and distribution throughout the western U.S., including western and central Montana and on the HLC NF. It is unknown whether, or to what degree, these changes are attributable to climate trends. Potential climate-induced trends of altered streamflow timing, lower summer flows, and increased water temperature would likely reduce the amount, quality, and distribution of habitat suitable for native trout and contribute to fragmentation of existing populations. Climate-related impacts are likely to add cumulatively to other stressors on native fish and amphibian species. Non-native trout and other aquatic species better adapted to warm water temperatures may increase in abundance and expand their existing ranges.

Westslope cutthroat trout and bull trout populations are sensitive to increased water temperatures (Bear, McMahon, & Zale, 2007; J. Dunham et al., 2003; Selong, McMahon, Zale, & Barrows, 2001). The latest science and modeling results (Isaak et al., 2015) for predicting localized climatic changes were reviewed to assess possible changes in summer water temperatures. Outputs from models which accurately back-predict historical temperatures were used for analyzing climatic effects on aquatic wildlife populations. It appears that these are relatively consistent in predicting that local, average summer air temperatures are predicted to increase between 2 to 4 degrees Celsius by 2050 (Dare et al., 2007); Barsugli 2009).

A warming climate would decrease biodiversity through a number of potential pathways; including invasive hybridization (Muhlfeld et al., 2014). Isaak and others (2010; 2012) concluded a warming climate has already increased stream temperature and the volume of available habitat is shrinking resulting in a bottle neck to key species.

Water temperatures in montane stream systems do not respond directly in magnitude to changes in maximum and average air temperatures. For instance, a one degree increase in average air temperature parameters will almost universally result in less than a one degree increase in either average or maximum water temperatures. Buffering influences from factors such as groundwater discharge, and the role of direct solar radiation in heating stream water, prevent this from occurring. In the plan's geographical area, for every degrees Celsius increase in air temperature, a 0.44 degrees Celsius increase in average water temperature is predicted (Isaak et al., 2010) Mohseni and Stefan 1999; Mohseni et al. 2003). This would indicate that under constant catchment basin characteristics, an increase in summer water temperatures ranging from 0.88 to 1.76 degrees Celsius could be expected between now and 2050. This extrapolated prediction is consistent with trends measured in recent decades of approximately 0.24 degrees Celsius per decade (Isaak et al., 2012). Extending this rate out to 2050 would match the low-end of this range without considering or adjusting for rate changes due to emission patterns or other influencing trends. This extrapolated range is also consistent with predictions found in a recently published paper (Isaak & Rieman, 2013). This article provides more of an accuracy check than an independent collaboration of the results brought forward in this assessment. Both efforts use similar citations and are primarily based on the same source data and modeling runs.

Decade-long averages of summer temperatures naturally vary across the North American continent. There is a pattern of warmer and cooler decades. Any future decade could fall at the margins of the historic variation before modeled increases are put into consideration.

One of the climate change related viability concerns for aquatic wildlife populations in this plan area is whether adding the predicted 0.88 to 1.76 degree Celsius increase to current maximum summer temperatures would lead to mortality concerns. The term "mortality concerns" in this context addresses temperature related fish-kill events that could reasonably be expected to occur during prolonged, extreme heat/drought events in the warmer sections of a stream. A fish-kill does not necessarily occur when temperatures exceed the critical thermal maximum for a species. The magnitude, duration, frequency of these events as well as the local microhabitat conditions are important factors. A weather event in which water temperatures slightly exceed a "reduced survivability threshold" for a few-minutes on only one day of the summer would be much less likely to create a fish-kill than a heat/drought event in which temperatures exceed the same threshold by a higher magnitude, across multiple hours each day and persisting over the span of several days.

There are climatic factors in addition to maximum summer water temperatures that affect survival and lifecycle completion for fish and mussel species. Thermal regimes in other seasons can affect the timing of spawning and the success of egg incubation. Earlier snowmelt run-off could increase scour during critical time periods in the lifecycles of trout, char, and mussels (Isaak et al., 2012). Earlier loss of snowpack also leads to lower summer flows which have been correlated within this plan area with decreased densities of westslope cutthroat trout (Nelson et al., 2011). Receding summer flows can lead to lower winter flows depending on fall precipitation events and effects of drought cycles on groundwater levels. Low winter flows are a concern as the critical over-wintering habitat is restricted.

Groundwater influence and discharges into surface water has been shown to both moderate temperature and be positively correlated with salmonid abundance (Ebersole, Liss, & Frissell, 2001). Perennial stream reaches in higher-elevation areas that have well-timbered valley bottoms and ground-water entry would be most resilient to warming conditions and changing weather patterns promoting earlier run-off. Lower elevation stream reaches, lacking riparian shade, containing high sediment loads, with impaired width-depth ratios, and losing flows to groundwater would be the least resilient reaches to changing conditions. This class of impacts often correlates spatially across the plan area with the stream reaches identified in the previous sentence as being least resilient to changing climatic conditions.

Future climate impacts to soils

Any future changes to length of growing season based on climate would affect soil and plant respiration. Typically, soils become active where temperatures exceed 44 degrees Fahrenheit and decrease in activity when soil moisture declines below 10 percent moisture (Davidson, Belk, & Boone, 1998). The combination of adequate temperature for growth is expressed as growing degree days. Using a 30 year compilation of mean annual data (Holden et al., 2015) growing degrees vary according to topographic gradient, aspect and valley form for the HLC NF. Bottomlands can have up to a 220 day growing season except where cold air drainage constrains growth. Middle elevations have from 160 to 200 day growing season varying mostly by aspect. In upper elevations, the cold air temperatures restrict the growing season down to 100 days with the greatest limitations above 7,500 feet. On areas that could experience longer seasonal drought, the effective growing degree days for soil respiration would decrease while upper elevations might have a longer growing season. As warming occurs, available soil moisture will be the primary control at mid to lower elevations. In Colorado, a study found that in complex terrain available water was the limiting factor to soil respiration for ponderosa and lodgepole (Berryman et al., 2015). On finer scales the outcome becomes complicated by the interaction of the forest canopy and topographic position. Soil water can be maintained by the shading of forest canopy which reduces evaporative losses from wind and sun.

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Appendix D. Terrestrial Wildlife and Plant Species Supplemental Information

The Forest adopted an ecosystem and species-specific approach, known as a coarse-filter/fine-filter approach, to provide for the diversity of plant and animal communities and the long-term persistence of native species in the plan area. The coarse-filter plan components are designed to maintain or restore ecological conditions for ecosystem integrity and ecosystem diversity in the plan area within Agency authority and the inherent capability of the land. The habitat needs of all plant and animal species are provided by plan components associated with the coarse filter of terrestrial vegetation conditions. Fine filter plan components are also written to specifically provide for the needs of some species due to their status (at-risk) or specific habitat needs that are not covered by the coarse filter.

This appendix provides species lists and information on wildlife and plant species to supplement Chapter 3 of the DEIS, including the habitat associations for each species.

Wildlife Species Habitat Associations

Table 1 lists wildlife species analyzed in the EIS and their habitat associations; it is not an exhaustive list of all the species found on the HLC NF. Habitat associations are groupings of vegetation types as referred to in the Terrestrial Wildlife Diversity section of the DEIS. Some species may use more habitat associations than indicated in Table 1, which is intended only to provide a general overview of terrestrial wildlife diversity on the HLC NF. SCC would be adopted with the action alternatives. Under the No Action alternative, the designations for Regional Forester Sensitive Species (RFSS) would be retained. Management indicator species (MIS) are not identified in the table, but would be included in the no action alternative.

Table 1. HLC NF Wildlife Species Habitat Associations

Species	Species Status	Grass-forb-shrub	Late-successional, old-growth, large trees	Snags	Coarse woody debris	Hard-wood Forest	High Elevation Habitats	Aquatic, Wetland, and/or Riparian	Dry Conifer (Warm-dry PVT)	Mixed Conifer (Warm Dry, Cool Moist, & Cold PVTs)	Cave, Cliff, Rock, other Geologic
Amphibians and Reptiles											
Western toad	RFSS		X					X			
Garter Snake								X	X		
Salamander			X		X	X		X			
Birds											
Bald eagle	RFSS							X			
Barred owl			X	X						X	
Black rosy finch							X				
Black-backed woodpecker	RFSS		X	X							
Boreal Owl			X							X	
Brown Creeper			X	X						X	
Clark's nutcracker							X		X		
Cooper's hawk										X	
Flammulated owl	SCC, RFSS		X	X					X		
Golden eagle											X
Gray-crowned rosy finch							X				
Great gray owls				X						X	
Harlequin duck	RFSS							X			
Hawk Owl				X						X	
Lewis's woodpecker	SCC		X	X		X			X		
Mountain bluebird				X					X		
Northern flickers				X		X		X		X	
Northern goshawk			X							X	
Northern (American) three-toed woodpecker				X						X	

Species	Species Status	Grass-forb-shrub	Late-successional, old-growth, large trees	Snags	Coarse woody debris	Hard-wood Forest	High Elevation Habitats	Aquatic, Wetland, and/or Riparian	Dry Conifer (Warm-dry PVT)	Mixed Conifer (Warm Dry, Cool Moist, & Cold PVTs)	Cave, Cliff, Rock, other Geologic
Nuthatch				X		X		X	X	X	
Peregrine falcon		X									X
Pileated woodpecker			X	X					X	X	
Screech Owl				X		X		X			
Sharp-shinned hawk										X	
Shorebirds and Waterfowl								X			
White-tailed ptarmigan							X				
Mammals											
Long-eared myotis	RFSS			X						X	X
Fringed myotis	RFSS								X	X	X
Silver-haired bat				X							
Townsend's big-eared bat	RFSS									X	X
Beaver						X		X			
Bighorn sheep	RFSS	X							X		X
Black bear		X				X		X	X	X	
Bobcat									X		
Bushy-tailed woodrat											X
Canada lynx	TEPC				X					X	
Coyote		X				X		X	X	X	
Deer		X				X		X	X	X	
Elk		X				X			X	X	
Fisher	RFSS		X					X		X	
Golden-mantled ground squirrel					X		X				X
Gray wolves	RFSS	X							X		
Grizzly bear	TEPC	X				X	X	X	X	X	
Hoary marmot							X				X

Species	Species Status	Grass-forb-shrub	Late-successional, old-growth, large trees	Snags	Coarse woody debris	Hard-wood Forest	High Elevation Habitats	Aquatic, Wetland, and/or Riparian	Dry Conifer (Warm-dry PVT)	Mixed Conifer (Warm Dry, Cool Moist, & Cold PVTs)	Cave, Cliff, Rock, other Geologic
Moose						X		X		X	
Mountain goat							X				X
Mountain lions					X				X		
Northern bog lemming	RFSS							X			
Northern flying squirrel			X	X	X	X				X	
Pika							X				X
Pine marten			X	X	X					X	
Red foxes		X									
Red squirrel					X	X				X	
Short-tailed weasel				X	X						
Shrews					X			X			
Snowshoe hare										X	
Voles		X			X			X			
Wolverine	TEPC						X				X

Plant Species Habitat Associations

Table 2 lists the plant species that are listed under the Endangered Species Act, those that were determined to be SCC, and those that were RFSS on the HLC NF and summarizes their habitat information. SCC would be adopted with all of the action alternatives. If the no alternative were selected, SCC would not be adopted. Rather, RFSS would be managed for by plan components.

Table 2. HLC NF Plant Species and associated habitat

Plant Species	Conservation Categories	Habitat Guild	Habitat Description
Adoxa moschatellina	SCC, RFSS, SOC, G3	Mesic-Montane-Disturbance-Talus	Vernally moist places in the mountains at the bottom of undisturbed, open rock slides that have cold air drainage.
Amerorchis rotundifolia	SCC, RFSS, SOC, Adjacent SCC	Wetland-riparian	Spruce forest around seeps or along streams, often in soil derived from limestone. High fidelity to a very narrow range of ecological tolerance that typifies a stable or near climax community and does not tolerate disturbance.
Aquilegia brevistyla	SCC, RFSS, SOC, S2	Wetland-riparian	Open woods and stream banks at mid-elevations in the montane zone.
Astragalus convallarius	SCC, SOC	Grasslands	Grasslands and open ponderosa pine woodlands in the valley and foothills. *Festuca scabrella, Festuca idahoensis* and *Elymus spicatus* are common bunchgrass associates.
Astragalus lackschewitzii	SCC, SOC, RFSS, S2, G2	Alpine	Open, gravelly and rocky slopes and ridgetops with calcareous soil and talus; subalpine to alpine.
Botrychium ascendens	RFSS, G3	Wetland-riparian	Stream, floodplains of glaciated bottoms dominated by shrubs with lush cover by forbs, grasses, and mosses in NW Montana. Often associated with wetlands dominated by spruce and alder. Mostly in sub-irrigated habitats 2700-6000 (9500) ft elevation
Botrychium crenulatum	SCC, RFSS, SOC, G3	Wetland-riparian	Various mesic sites from low to moderate elevations, including roadsides and other disturbed habitats. Can occur in open habitats, but more often in closed canopy habitats.
Botrychium paradoxum	SCC, RFSS, SOC, G3, Adjacent SCC	Wetland-riparian	Mesic meadows associated with spruce and lodgepole pine forests in the montane and subalpine zones; also found in springy western red cedar forests.
Braya humilis	SCC, SOC, S2 (S1 Nature Serve)	Mesic-Montane-Disturbance-Talus	*(Neotorularia humilis)* Sparsely vegetated, vernally moist, calcareous soil in the alpine zone and similar sites with sparse vegetation cover dominated by *Potentilla fruticosa, Carex scirpoidea, Phlox kelseyi* and *Zigadenus elegans* in montane settings along the Rocky Mountain Front.
Carex chordorrhiza	RFSS, Adjacent SCC, SOC	Peatlands	Wet, organic soil of fens in the montane zone

Plant Species	Conservation Categories	Habitat Guild	Habitat Description
Carex rostrata	RFSS, SOC, S2	Peatlands	Wet, organic soils of fens in the montane zone, including floating peat mats
Castilleja kerryana	SCC, SOC, G3	Alpine	Rocky or gravelly limestone substrates of Cambrian origin; slopes and ridges from upper subalpine krummholz or turf communities in upper alpine fell fields
Cypripedium parviflorum	SCC, RFSS, S3	Wetland-riparian	Fens, damp mossy woods, seepage areas, and moist forest-meadow ecotones in the valley to lower montane zones.
Cypripedium passerinum	SCC, RFSS, SOC,S2, Adjacent SCC	Wetland-riparian	Fens, damp mossy woods, seepage areas, and moist forest-meadow ecotones in the valley to lower montane zones.
Delphinium bicolor ssp. *calcicola*	SCC, T3 (variety equivalent to G3)	Grasslands	Shortgrass prairie and grass-sagebrush communities on limestone-derived soils, usually with coarse fragments at the surface, or on limestone outcrops. 4000-7000 m elevation.
Draba densifolia	SCC, SOC, S2	Alpine	Gravelly, open soil of rocky slopes and exposed ridges in the montane to alpine zones.
Drosera anglica	SCC, RFSS, SOC	Peatlands	With sphagnum moss in wet, organic soils of fens in the montane zone.
Drosera linearis	SCC, RFSS, SOC, S2, Adjacent SCC	Peatlands	With sphagnum moss in wet, organic soils of fens in the montane zone.
Erigeron lackschewitzii	RFSS, SOC, G3	Alpine	Exposed alpine settings (gravelly talus) with water-retaining calcareous soil derived from a dolomite substrate, rock-covered surfaces impeding water loss from shallow soil beneath, exposed, windy sites (saddles, protruding outcrops, crests of updraft chutes), and areas with first snowmelt and late soil recharge above 6000 ft.
Eleocharis rostellata	SCC, RFSS, SOC, Adjacent SCC	Peatlands	Wet, often alkaline soils, associated with warm springs or fens in the valley and foothills zones.
Elymus innovatus	SCC, RFSS, SOC, S2	Grasslands	Moist meadows, forest margins and openings along rivers and streams in the valley and lower montane zones.
Epipactis gigantea	SCC, RFSS, SOC, S2, Adjacent SCC	Wetland-riparian	Stream banks, lake margins, fens with springs and seeps, often near thermal waters.
Erigeron flabellifolius	SCC, SOC, G3	Mesic-Montane-Disturbance-Talus	Gravelly soil or talus in the subalpine and alpine zones.
Gentianopsis macounii	SCC, RFSS, SOC, S2	Peatlands	Wet, organic soil of calcareous fens in the valley and foothill zones.
Goodyera repens	SCC, RFSS, SOC	Mesic-Montane-Disturbance-Talus	North-facing, mossy forested slopes in the montane zone.

Plant Species	Conservation Categories	Habitat Guild	Habitat Description
Grindelia howellii	SCC, SOC, RFSS, G3, S2, Adjacent SCC	Grasslands	Vernally moist, lightly disturbed soil adjacent to ponds and marshes, as well as similar human-created habitats, such as roadsides and grazed pastures.
Juncus hallii	RFSS	Wetland-riparian	Moist grassland and sedge meadows from the montane to alpine zones. Flats or benches on the gentle to mid-upper slopes (3500) 6000-8800 feet elevation
Lycopodium dendroideum	SCC, RFSS, SOC, S2	Mesic-Montane-Disturbance-Talus	Moist, coniferous forest in the valley and lower montane zones.
Micranthes tempestiva	RFSS, G2, S2, SOC	Mesic-Montane-Disturbance-Talus	Vernally moist, open soil in meadows and on rock ledges in subalpine and alpine zones 7500-9500 feet elevation
Oxytropis podocarpa	RFSS, SOC, S1	Alpine	Gravelly ridges and slopes, often on limestone, in the alpine zone. Basins or on steep slopes and ridges with limestone-derived soils, 6500-8500 feet elevation
Phlox kelseyi var. *missoulensis*	SCC, RFSS, SOC, G3	Grasslands	Open, exposed, limestone-derived slopes in the foothills to exposed ridges in the subalpine zone.
Pinus albicaulis	TES - Candidate	Alpine	High elevation, harsh, exposed slopes and ridgetops
Polygonum austiniae	SCC, RFSS, SOC	Mesic-Montane-Disturbance-Talus	*(Polygonum douglasii var. austiniae)* Gravelly, often shale-derived soil of open slopes and banks in the montane zone.
Potamogeton obtusifolius	SCC, RFSS, SOC	Aquatic	Open water; Shallow water of lakes, ponds, and sloughs in the valley, foothill, and montane zones.
Potentilla nivea var. pentaphylla	RFSS, SOC	Alpine	Dry, shallow, gravelly soil or talus and scree of exposed ridges, slopes, and summits in the montane to alpine zones 4600-10000 ft elevation
Ranunculus pedatifidus	SCC, SOC	Wetland-riparian	Moist meadows and open woodlands in the montane to alpine zones.
Salix barrattiana	RFSS, S2, SOC	Alpine	Alpine habitat, 6500 – 9500 ft elevation
Schoenoplectus subterminalis	SCC, RFSS, SOC	Aquatic	Open water and boggy margins of ponds, lakes, and sloughs at 0.1-3 m depth in the valley, foothill, and montane zones.
Scorpidium scorpioides	SCC, RFSS, SOC, S2, Adjacent SCC	Peatlands	Exposed or submerged rocks in rivers and streams. Also found on wet soil in calcareous seeps and fens, and soil of bogs, ponds, and other wetlands. From low elevations to about 10,000 feet.
Sphagnum fimbriatum	SCC, SOC, S1	Peatlands	Nutrient-rich wet soil and peat, at the edges of bogs and poor fens on mineral soil, somewhat exposed to wooded fens. Elevation: low to high.
Stipa lettermanii	SCC, SOC, S1	Mesic-Montane-Disturbance-Talus	Coniferous forest (*Pinus contorta* and *Picea engelmannii*) with openings.

Plant Species	Conservation Categories	Habitat Guild	Habitat Description
Thalictrum alpinum	RFSS, S2, SOC	Mesic-Montane-Disturbance-Talus	Typically moist meadows or stony slopes in montane and lower subalpine areas. Can occur on drier, upper portions of hummocks. Sometimes along streams 4500-8500 feet elevation.
Trichophorum cespitosum	RFSS, S2, Adjacent SCC, SOC	Peatlands	Sphagnum-dominated fens and wet meadows in the montane to alpine zones. Rare in Montana.
Veratrum californicum	RFSS, S2, SOC	Wetland-Riparian	Wet meadows and streambanks in the montane and subalpine zones 5500-8000 feet elevation.

RFSS = Regional Forester Sensitive Species (alt A); SCC = Species of Conservation Concern (action alts); SOC = species of concern; S1 = state ranking 1; S2 = state ranking 2; G3 = global ranking 3.

Other Plant Species of Interest

Culturally Important Plant and Fungi Species

Several culturally important plant and fungi species are present on the HLC NF. Culturally important species include those that have been used historically and/or are presently used for ceremonies, rituals, nutrition, or medicinally. Small camas (*Camassia quamash*), thinleaf huckleberry (*Vaccinium membranaceum*), chokecherry (*Prunus virginiana*), common beargrass (*Xerophyllum tenax*), and bitterroot (*Lewisia rediviva*) are all culturally important plant species that occur on both forests. While small camas, thinleaf huckleberry, chokecherry, and bitterroot are prized for their edibility, common beargrass is important to western North American indigenous peoples for basketry, regalia, and medicinal purposes. Morel (*Morchella spp*.) mushrooms, highly prized for their flavor, are culturally important edible fungi species hunted and harvested by many across both forests.

Plant species of other interest

In addition to potential SCC, other plants and communities are of interest to the public or resource specialists. The values placed on these species include considerations such as high value or limited wildlife habitats, recreational uses, spiritual values, or importance to ecosystem integrity. Four plant guilds are identified as communities of interest; these are addressed in further detail in the Terrestrial Vegetation section because they are components of the coarse filter analysis for nonforested vegetation.

- Grasslands
- Mesic shrubland
- Shrub-steppe
- Xeric ecotones

Twelve individual species are identified as plants of interest.

- *Artemisia tridentata subsp. vaseyana* (mountain big sagebrush)
- *Camassia quamash* (camas)
- *Cercocarpus ledifolius* (mountain mahogany)
- *Lewisia rediviva* (bitterroot)
- *Purshia tridentata* (antelope bitterbrush)
- *Salix spp*. (willow)
- *Prunus virginiana* (chokecherry)
- *Vaccinium membranaceum* (thinleaf huckleberry)
- *Juniperus scopulorum* (rocky mountain juniper)
- *Pinus flexilis* (limber pine)
- *Pinus ponderosa* (ponderosa pine)
- *Populus tremuloides* (quaking aspen)

Artemisia tridentata subsp. vaseyana (Mountain Big Sagebrush)

Mountain big sagebrush (*Artemisia tridentata subsp. vaseyana*), an aromatic shrub of the Asteraceae family, dominates much of the shrub-steppe plant community across the HLC NF. It generally occupies open dry sites at elevations below montane forests where winters are cold and dry, spring and early summer months receive most precipitation, and drought is expected from mid-summer through the fall (Welch, 2005). Sagebrush steppe vegetation dominated by mountain big sagebrush is also characterized by the presence of native forbs and cool season perennial bunch grasses (e.g., Agropyron, Festuca, Koeleria, Poa, Stipa). Sagebrush steppe vegetation on the HLC NFs has high levels of native plant species diversity and provides essential habitat requirements for many wildlife species, such as the sagebrush sparrow (*Artemisiospiza belli*), greater sage-grouse (*Centrocercus urophasianus*), pronghorn antelope (*Antilocapra americana*), and sagebrush vole (*Lemmiscus curtatus*), while also providing valuable grazing land for livestock.

Mountain big sagebrush is sensitive to encroachment by conifers; studies have shown that in southwestern Montana, it is declining due to competition from Douglas-fir (Grove, Wambolt, & Frisina, 2005; Gruell, Brown, & Bushey, 1986). Douglas-fir expansion into grass and shrub communities may in part reflect natural ecotone dynamics, but overgrazing, climate changes, and fire exclusion have likely caused more extensive encroachment than would be present naturally. This species is also addressed in the Terrestrial Vegetation section of the DEIS.

Camassia quamash (Camas)

Camassia quamash (small camas) occurs in deep soils of wet meadows across the HLC NF. It is important to traditional cultures for nutrition, ceremonies, or rituals. Camas is apparently secure in Montana. Because digging the roots destroys the entire plant, care should be taken with regards to harvest in order to maintain populations.

Cercocarpus ledifolius (Curl-leaf Mountain Mahogany)

Cerocarpus ledifolius (*curl-leaf mountain mahogany*) is an evergreen shrub that occurs on limestone or sandstone stony slopes, cliffs, and rock outcrops from valleys to montane zones across the HLC NF. It grows in a variety of plant communities, including rocky habitats, xeric ecotones, and shrub-steppe. While its flowers are small and inconspicuous, the silver-haired, spiral, persistent style attached to each seed is notable. It provides an important food and cover source for wildlife year-round. Traditional cultures have used it for fuel, dyes, and many important medicinal purposes. Curl-leaf mountain mahogany is apparently secure in Montana. Although, with more frequent high severity fires, often related to increased fine fuel loads from exotic annual grasses, curl-leaf mountain mahogany populations are declining in many areas throughout its range (Hanson et al, 1999), as it is not a fire-sprouter and is killed by fires. This species is also addressed in the terrestrial vegetation section of the DEIS.

Kelseya uniflora (One-flower kelseya)

One-flower kelseya is a unique species that occupies crevices and limestone cliffs on the HLC NF. It creates large cushions and exhibits bright pink flowers in the spring. Naturalists seek out this plant for its unique habitat and early spring color. One-flower kelseya is endemic to Montana where it is apparently secure. In the adjacent state of Wyoming, it is considered imperiled. Due to the unique habitat one-flower kelseya occupies, disturbance is unlikely to impact populations. Climate change may contribute to changes in range or extent of populations.

Lewisia rediviva (Bitterroot)

Bitterroot occurs in well drained soils of sparsely vegetated grasslands across the HLC NF. It is important to traditional cultures for nutrition. Bitterroot is apparently secure in Montana. Because digging the roots destroys the entire plant, care should be taken with regards to harvest in order to maintain populations.

Purshia tridentata (Antelope Bitterbrush)

Antelope bitterbrush, a three to six foot tall shrub in the Rosaceae family, infrequently occurs on stony or sandy soil of grasslands, shrub-steppe, and open ponderosa-pine forest from valley to montane zones across the HLC NF. It provides an important food and/or cover source for ungulates, rodents, birds, and several insect species. Traditional cultures also use bitterbrush for many medicinal purposes. This species is also addressed in the terrestrial vegetation section of the DEIS.

The abundance and distribution of bitterbrush is largely influenced by climate and fire regimes. As a shade intolerant, nitrogen-fixing shrub, it is an early colonizer on disturbed sites in several plant communities (e.g., xeric ecotones, shrub-steppe) on the HLC NF. It competes with nonnative, invasive, annual grasses such as cheatgrass (*Bromus tectorum*), which are spreading rapidly throughout bitterbrush habitat. This invasion has increased fine fuel loads, causing more frequent high severity fires, where bitterbrush, considered a weak sprouter, is often killed. Sprouting ability following fire is influenced by fire severity and season, where bitterbrush may sprout following light-severity fires that occur in spring (Zlatnik, 1999). In Montana, bitterbrush communities have experienced declines of 10-30% in population size, range extent, and/or occupied area during the past 30 years.

Salix spp (Willow)

Many species of willow exist, and are of interest because of their habitat value, limited extent, and pressures exerted by factors such as grazing and fire suppression. Willows require a seasonally high water table and free water in the soil to survive and regenerate. Most species are shade-intolerant and those species that occur along streams in narrow steep valleys would likely not persist if conifers overtop and shade them. Browsing pressure by both native and domestic ungulates can lead to loss of vigor and eventually death if it is chronic and persists. These species are also addressed in the terrestrial vegetation section of the DEIS.

Prunus virginiana (chokecherry)

Chokecherry is often associated with mesic shrublands, moist forest, or riparian areas. It is important to traditional cultures for nutrition, ceremonies, rituals, and medicinal purposes. The berry is sought after and collected by members of the public for wildcrafting purposes. Chokecherry is secure within its range.

Vaccinium membranaceum (thinleaf huckleberry)

Thinleaf huckleberry occurs across the HLC NF and prefers open coniferous woods. It is important to traditional cultures for nutrition, ceremonies, rituals, or medicinal purposes as well as a food staple for wildlife. Commercial collections also occur for wildcrafting purposes. The abundance and distribution of thinleaf huckleberry is largely influenced by disturbance including fire regimes. Although thinleaf huckleberry can be difficult to establish, it often responds to favorably to disturbance and in the absence of natural fire, thinleaf huckleberry is less productive than it would have been historically.

Juniperus scopulorum (Rocky Mountain Juniper)

Rocky mountain juniper is a component of xeric ecotones as well as an understory species in dry forests. The abundance and distribution of juniper is largely influenced by climate and fire regimes. It tends to become abundant in the later stages of succession, where it slowly becomes established after other grasses and shrubs. This species is addressed further in the terrestrial vegetation section of the DEIS.

Pinus flexilis (limber pine)

Limber pine is a relatively long-lived, native five-needled pine which grows east of the Continental Divide. Although marginal for timber values, limber pine is an important pioneer species that provides watershed protection and wildlife habitat; it grows on dry sites at both upper and lower tree lines and in between on sites too harsh for other conifer species (Jackson et al. 2010). It occurs in the xeric ecotone and rocky habitats guilds, and on the HLC NFs its presence correlates with limestone substrates. It grows in association with whitebark pine at high elevations on the HLC NFs. This species is identified as a focal species for monitoring, and is addressed in further detail in the terrestrial vegetation section of the DEIS.

Pinus ponderosa (ponderosa pine)

Ponderosa pine is a shade-intolerant species that is highly resistant to fire mortality when mature due to its thick exfoliating bark, high open crown, high foliar moisture content, large buds, deep roots, and the ability to self-prune (Saveland, Bakken, & Neurenschwander, 1990). This species is addressed further in the terrestrial vegetation section of the DEIS.

Populus tremuloides (quaking aspen)

Aspen is highly valued for its contribution to biodiversity and habitat; with the exception of riparian areas, aspen communities are considered the most biologically diverse ecosystems in the Intermountain West (Campbell and Bartos 2001). It is addressed further in the terrestrial vegetation section of the DEIS.

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Appendix E. Recommended Wilderness Analysis Process

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Recommended Wilderness Process

When developing or revising a forest plan, the FS must identify and evaluate lands that may be suitable for inclusion in the National Wilderness Preservation System and determine whether to recommend any such lands to be designated as wilderness. This is done in four steps: inventory, evaluation, analysis, and recommendation. An opportunity for public input and review is required after each of these steps.

In all of the tables in this document, the acres reported are approximate.

Inventory and Evaluation

The wilderness inventory was developed using both the size and the improvements criteria outlined in Chapter 70 of the 2015 Final Land Management Planning Directives, FSH 1909.12. The HLC NF identified 46 distinct areas that had potential for inclusion based on this criteria. Maps of the wilderness inventory polygons and documentation of the inventory process were made available for public review in November of 2015.

Each of the areas identified in the wilderness inventory step were evaluated to determine their potential suitability for inclusion in the National Wilderness Preservation System using the criteria included in the Wilderness Act of 1964. An opportunity for public review of the evaluation of the wilderness polygons was made available with the release of the proposed action in March 2016.

A more detailed review of the inventory and evaluation steps is documented in appendix F of the Draft Plan, along with maps of all wilderness inventory polygons. In appendix F, the factors that guided the selection of recommended wilderness for the proposed action (alternatives B and C) are described.

Analysis

Based on the evaluation of the inventory and input form public participation, the responsible official identified specific areas to take forward as recommended wilderness areas (RWAs) in the alternatives in the DEIS. Not all of the lands included in the inventory and studied in the evaluation steps are required to be carried forward in an alternative and studied in the DEIS. Maps of each RWA included in the alternatives are located in appendix A of the DEIS. In addition to the analysis in the DEIS, the FSH 1909.12, chapter 70, requires that the following items be discussed for each RWA in each Alternative where it was identified:

- The name of the area and number of acres to be considered for recommendation;
- The location and a summarized description of a boundary for each recommended area;
- A brief description of the general geography, topography and vegetation of the recommended area;
- A brief description of the current uses and management of the area.
- A description of the area’s wilderness characteristics and the ability to protect and manage the area so as to preserve its wilderness characteristics;
- A brief summary of the factors considered and the process used in evaluating the area and developing the alternatives;
- A brief summary of the ecological and social characteristics that would provide the basis for the area’s suitability for inclusion in the National Wilderness Preservation System.

Alternatives

Table 1 provides a snapshot of the RWAs that are included in each alternative, including the GA where it is located, the inventory polygon it originated from, and the approximate acres.

Table 1. Recommended wilderness areas included in each alternative

RWA	GA	Wilderness Inventory Polygon	Alternative A Acres	Alternatives B and C Acres	Alternative D Acres
Big Log	Big Belts	BB1	9,150	7,086	7,086
Camas Creek	Big Belts	BB6	- -	- -	22,350
Mount Baldy	Big Belts	BB7	8,420	8,314	8,314
Wapiti Peak	Castles	CA1	- -	- -	30,606
Loco Mountain	Crazies	CR1	- -	- -	24,977
Blackfoot Meadows/ Electric Peak	Divide	D3	16,657	18,296	26,900
Colorado Mountain	Divide	D5	- -	- -	14,189
Deep Creek	Little Belts	LB1a	- -	14,490	14,490
Tenderfoot Creek	Little Belts	LB1b	- -	- -	45,870
Big Horn Thunder	Little Belts	LB2	- -	- -	47,107
Middle Fork Judith	Little Belts	LB16	- -	- -	62,452
Big Snowies	Snowies	S1	- -	95,299	95,299
Dearborn Silverking	Upper Blackfoot	UB1	- -	20,088	20,088
Red Mountain	Upper Blackfoot	UB2a	- -	1,901	1,901
Arrastra Creek	Upper Blackfoot	UB2b	- -	8,257	8,257
Nevada Mountain	Upper Blackfoot	UB10	- -	39,345	44,702
			34,227	**213,076**	**474,589**

Alternative A, the no-action alternative is based on the 1986 Forest Plan, which has three RWAs totaling approximately 34,227 acres. These RWAs are under the guidance of the 1986 Helena NF Plan.

The nine RWAs identified in Alternatives B and C are located on 5 GAs and total approximately 213,076 acres. These RWAs were derived from the wilderness inventory polygons identified in the first step of the wilderness evaluation process, but do not necessarily include all of the original acres. They were selected based on consideration of the information in the wilderness evaluation, which indicated these areas had wilderness characteristics such as naturalness, undeveloped, outstanding opportunities for solitude or a primitive and unconfined recreation or other special features such as ecological, geological, or scientific, educational, scenic or historic value. Boundaries for the RWAs were redrawn to tie the boundary lines to naturally occurring ridgelines, stream bottoms, or other locatable features on the landscape to make them more manageable.

Alternative D responds to comments received during pubic scoping asking the Forest to consider an alternative that increased the amounts of RWAs and primitive recreation opportunities. Alternative D identifies sixteen (16) RWAs. These RWAs include the nine areas identified for Alternatives B and C as well as seven additional areas. Additional acreages were also added to the Nevada Mountain and Blackfoot Meadows RWAs in this alternative. The RWAs in Alternative D are located across seven geographic areas and total roughly 474,589 acres. All of the recommended wilderness areas for

Alternative D were derived from the original wilderness inventory polygons identified in the first step of the wilderness evaluation process, but do not necessarily include all of the original acres of those wilderness inventory polygons.

No areas were recommended for wilderness in alternative E to respond to issues identified in the scoping of the proposed action. Scoping comments identified a desire to not recommend any acres to be managed as recommended wilderness. While the wilderness inventory displays many areas and acres that possess wilderness characteristics, this alternative is designed to respond to the public input received in scoping and to display a reasonable range of alternatives as required under NEPA.

Recommended wilderness area analysis by alternative

Big Log Recommended Wilderness Area

The Big Log RWA was included in the 1986 Helena NF Plan. The area description is based on the Big Log wilderness inventory polygon, Big Belts 1 (BB1). This area is included as a RWA in alternatives A, B, C, and D. The boundary is the same for alternatives B, C, and D, and varies slightly for alternative A.

Table 2. Big Log recommended wilderness area

Analysis Criteria	Description
Acres – alternative A	9,150 (alternative A); 7,086 (alternatives B, C, D)
Description of the recommended boundary - alternative A	The RWA is comprised of three parcels. The northern parcel follows section 18 13 N 2 W from the east, north, west the south section of the Gates of the Mountains Wilderness and section 19 to complete the north parcel. The western parcel traverses the east boundary of the Gates of the Mountains Wilderness area and follows the south ridgeline of the Merriweather picnic site and then follows the Missouri river to the west. The southern boundary follows section line 1, and 6 T13 N 2 W and borders private property to complete the southern portion of the boundary. The southeast parcel north follows the Gates of the Mountains Wilderness Boundary and south buffering Beaver Creek Indian Creek Rd 138. The east boundary follows Big Log Gulch and American Bar Rd 1812 to section line 7 and 8 T 12 R 2.
Description of the recommended boundary – alternatives B, C, D	The RWA is comprised of five parcels. The northeast parcel boundaries south and east boundary border the Gates of the Mountains Wilderness. The north and west boundary borders a Montana State parcel. The north central boundary borders a Montana State section east, north and west. The southern boundary borders the Gates of the Mountains Wilderness boundary. The north western parcel follows a Montana state section boundary to the north, west and southern boundary. The eastern boundary follows the adjacent Gates of Mountains wilderness. The Southwest parcel follows the Gates of the Mountains Wilderness boundary from the south to the east. The northern and western boundary follows a Montana state parcel. The southeast parcel north follows the Gates of the Mountains Wilderness Boundary and south buffering Beaver Creek Indian Creek Rd 138. The east boundary follows Big Log Gulch and American Bar Rd 1812 to section line 7 and 8 T 12 R 2.
Description of the geography, topography, and vegetation	Much of the area is moderately steep to very steep, with limestone cliff features adjacent to the Missouri River as well as other unique geological landforms. Existing vegetation includes dry grasslands, shrublands, open and dry ponderosa pine forests, and Douglas-fir forests, along with small amounts of lodgepole pine, and Rocky Mountain juniper.
Current uses and management	The 1986 Helena NF Plan included this area as a RWA. Except for the river corridor, which is semi-primitive motorized, the entire polygon is available for primitive recreation opportunities in both summer and winter. There are no motorized trails, or open roads, or motorized over snow uses. There are 5.3 miles of non-motorized trail.

Analysis Criteria	Description
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized uses. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: horseback riding, hiking, backpacking, dispersed camping, hunting, and cross country skiing. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. Areas that are closer to the Gates of the Mountains wilderness have greater opportunity for solitude, and this diminishes in areas closer to the Missouri River and the Beaver Creek road. **Other Features of Value** –Features of this area include an introduced population of mountain goats; cliffs and rock formations along the river corridor and Meriwether Canyon; the unique rock formations and slot canyon in Refrigerator Canyon; many cultural resources including cabin ruins, tipi ring, mining and prehistoric rock art sites; and the Beaver Creek eligible Wild & Scenic River; and rare plant and animal species such as grizzly bear, lynx, flammulated owl, and Lewis' woodpecker.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because the area is adjacent to existing wilderness and has been managed as recommended wilderness since 1986. It is also within Big Log inventoried roadless area, and is adjacent to the Devil's Tower inventoried roadless area to the south. There are no motorized uses. Mechanized uses on non-motorized trails would be discontinued in alternative B but allowed to continue in alternative C.
Summary of the factors considered and the process used in evaluating the area and developing the alternatives	o A large portion of this area was previously included as a RWA in the 1986 Forest Plan. o This RWA is located adjacent to the existing Gates of the Mountain wilderness and would expand it. o High interest exists for this area to be RWA; a majority of public comments received were in in favor of the designation. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as it is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high and there are no motorized uses. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for horseback riding, hiking, backpacking, dispersed camping, hunting, and Nordic skiing.

Camas Creek Recommended Wilderness Area

This RWA is derived from portions of the Camas Creek Wilderness Inventory Area, Big Belts 6 (BB6). It is included only in alternative D.

Table 3. Camas Creek recommended wilderness area

Analysis Criteria	Description
Acres	22,350 acres (alternative D)

Analysis Criteria	Description
Description of the recommended boundary	The Camas Creek RWA's northeastern boundary buffers Atlanta Mule Road north bordering a private property section to the north and ridgeline to the northwest. The western borders private property parcels. The southwestern boundary then follows the GA boundary. The southern boundary follows the existing ridgeline and private property section boundary. The southeast boundary follows Duck Creek to Camas Ridge to complete the area.
Description of the geography, topography, and vegetation	Camas Creek RWA is located in the Big Belts GA and contains the high peaks of Boulder Mountain and Boulder Baldy. It also contains the Boulder Lakes and Camas Lakes. This area contains a mix of vegetation, including Douglas-fir, lodgepole pine, and subalpine fir/Engelmann spruce forests. There are also dry grasslands, whitebark pine forest, and very small amounts of shrublands, limber pine, aspen, and sparse vegetation (scree slopes).
Current uses and management	This area is in Camas Creek inventoried roadless area. There are no motorized trails or motorized over-snow uses, but 0.3 miles of open road occur in the polygon. Most of the area is available for primitive and semi-primitive non-motorized summer and winter recreation opportunities. There are 16 miles of nonmotorized trails.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized trails or motorized over-snow uses. 0.3 miles of open road are present in the area. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hiking, horseback riding, hunting, fishing, and backpacking in to high mountain lakes. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. This value is diminished in close proximity to the 0.3 miles of open road. **Other Features of Value** – Features of this area include an introduced population of mountain goats; the Confederate Historic Mining District; high mountains (Boulder Mountain and Boulder Baldy), wide vistas, and small alpine lakes; and rare plant and animal species such as grizzly bear, whitebark pine, lynx, and wolverine.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is within Camas Creek inventoried roadless area. There are no private land inholdings. There are no motorized trails or motorized over-snow uses. There are currently 0.3 mile of open road; this use along with mechanized use on the 16 miles of nonmotorized trails would be discontinued under alternative D.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o High interest exists for this area based on public comment. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for hiking, horseback riding, hunting, fishing, and backpacking in to high mountain lakes.

Mount Baldy Recommended Wilderness Area

The Mount Baldy RWA was included in the 1986 Helena NF Plan. The area description is based on the Mount Baldy wilderness inventory polygon, Big Belts 7 (BB7). This area is included as a RWA in alternatives A, B, C, and D. The boundary is the same for alternatives B, C, and D, and varies in alternative A.

Table 4. Mount Baldy recommended wilderness area

Analysis Criteria	Description
Acres	8,420 (alternative A); 8,314 acres (alternatives B, C, D)
Description of the recommended boundary – alternative A	The RWA's northern boundary follows a private property section, pack trail 150 and the existing ridge line west. The western boundary follows the Broadwater County and Meager County boundary to make the south and southeast boundary. The east boundary follows a private property parcel to complete the area.
Description of the recommended boundary – alternatives B, C, D	The RWA's northern boundary follows a private property parcel, pack trail 150 and the existing ridgeline west. The west boundary buffers microwave Spur Road 082 and follows the Broadwater and Meager County boundaries to make the south and southeast boundary. The east boundary follows private property to complete the area.
Description of the geography, topography, and vegetation	This area includes several high peaks (Mount Baldy and Mount Edith), and includes the Needles rock formation, numerous alpine lakes, and valley vistas. Vegetation is dominated by high elevation lodgepole pine and subalpine fir/Engelmann spruce forests, with some Douglas-fir forests. Sparsely vegetated areas are common, including rocky alpine sites. Whitebark pine forest is also present, along with grasslands, shrublands, and limber pine.
Current uses and management	The 1986 Forest Plan included this area as a RWA. The entire polygon is available for primitive and semi-primitive summer and winter recreation. There are no open roads, motorized trails, or motorized over snow uses. There are 13.6 miles of nonmotorized trail.
Description of the wilderness characteristics.	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized uses. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: horseback riding, hiking, backpacking, dispersed camping, and hunting. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. This is slightly diminished in close proximity to the communication site road in the summer. **Other Features of Value** –Features of this area include an introduced population of mountain goats; numerous high alpine lakes; the Needles unique rock formations; unique wetland vegetation; and rare plant and animal species such as whitebark pine, grizzly bear, lynx, wolverine, black rosy finch, and westslope cutthroat trout in Ray Creek.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage wilderness characteristics is high because the area has been managed as a RWA since 1986, and contains no private inholdings. The area is located in the Mount Baldy Inventoried Roadless Area. The only administrative motorized use is on the road to the communication site in the summer. There are no motorized uses. Mechanized uses on non-motorized trails would be discontinued in alternative B but allowed to continue in alternative C.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o A large portion of this area was previously included as a RWA in the 1986 Forest Plan. o High interest exists for this area to be recommended for wilderness. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.

Analysis Criteria	Description
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high, with no motorized uses. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for horseback riding, hiking, backpacking, dispersed camping, and hunting.

Wapiti Peak Recommended Wilderness Area

This RWA was derived from the Wapiti Peak wilderness inventory area, Castles 1 (CA1). It is included only in alternative D.

Table 5. Wapiti Peak recommended wilderness area

Analysis Criteria	Description
Acres	30,606 acres (alternative D)
Description of the recommended boundary	The Wapiti Peak RWA consists of four parcels. The small three parcels follow the boundary of three small inholdings within the interior of the larger parcel. The larger parcels northeastern boundary follows the existing ridgeline north buffering Four Mile and Grasshopper road to the northwest and also following the GA boundary southwest bordering a private property sections south and south east. The southeastern and eastern boundary then follows Hamilton Creek trail and Hamilton Ridge trail to complete the area.
Description of the geography, topography, and vegetation	Wapiti Peak RWA is located in the west side of the Castles GA and contains a series of high peaks including Beartrap Peak, Woodchuck Mountain, Wapiti Peak, Elk Peak, and Castle Mountain. The area is characterized by numerous castle-like outcrops of granite. Most of the higher elevations are covered by forest with large open grasslands dominating the lower elevations. The most common vegetation is lodgepole pine forest, as well as Douglas-fir, subalpine fir, and Engelmann spruce. Dry grasslands are also present, along with small amounts of whitebark pine, limber pine, including shrublands, and cottonwood.
Current uses and management	This area is in the Castle Mountains inventoried roadless area. With 6.1 miles of open road and 31.9 miles of motorized trail, most of the area is available for summer motorized activity and therefore there is little opportunity for primitive or semi-primitive non-motorized recreation in the summer. There are 9.5 miles of nonmotorized trail. The majority of the area is also open to snowmobile use in the winter, although the terrain and vegetation make this use impracticable and therefore there are opportunities for primitive or semi-primitive non-motorized recreation in the winter.

Analysis Criteria	Description
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – Much of this area is undeveloped and not affected by human intervention. However, motorized use is allowed on open roads and trails in the summer, as well as over-snow use over most of the area in the winter. **Unconfined and/or primitive recreation** – This area has unconfined and primitive recreation opportunities: horseback riding, hiking, rock climbing, hunting, fishing, mountain biking, dispersed camping around the periphery, and recreational mining. **Solitude** – There is outstanding opportunity for solitude in the winter as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. Opportunities for solitude in the summer are diminished by curren motorized uses. **Other Features of Value** – Features of this area include Castle geology and outcroppings; cultural resources; municipal watershed for White Sulphur Springs; sinkhole wetlands; and rare species such as whitebark pine and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because this area is within the Castle Mountains inventoried roadless area. There are two small private land inholdings (patented mining claims). The motorized uses on open roads and motorized trails, along with over-snow motorized use in the winter, would be discontinued under alternative D. In addition, mechanical means of transport on nonmotorized trails would also be discontinued under alternative D.
A summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Opportunities for solitude o High interest exists for this area based on public comment. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is high. The social characteristics that provide the basis for suitability include: o The area offers opportunities for solitude. o There is high amount of primitive and/or unconfined recreation for horseback riding, hiking, rock climbing, hunting, fishing, mountain biking, dispersed camping around the periphery, and recreational mining.

Loco Mountain Recommended Wilderness Area

This RWA was derived from the Loco Mountain wilderness inventory polygon, Crazies 1 (CR1). It is included only in alternative D.

Table 6. Loco Mountain recommended wilderness area

Analysis Criteria	Description
Size	24,977 acres (alternative D)

Analysis Criteria	Description
Description of the recommended boundary	The Loco Mountain RWA's northeastern boundary follows the GA boundary and buffers Station Spring Road. The northern boundary then follows private property inholdings to the northwest. The western boundary buffers Forest Lake Road and Forest lake Guard Station and follows and a private property parcel to the southwest. The southwestern boundary follows the ridgeline buffering a road system continuing to the ridgeline of Target Peak. The southern boundary follows Crow Creek Trail and Lebo Fork Ridgeline and buffering American Fork Road to the southeast. The eastern boundary follows private property inholding boundaries to the northeast and the GA boundary to complete the area.
Description of the geography, topography, and vegetation	Loco Mountain RWA is located on the east side of the Crazies GA, at the north end of the mountain range and shares a border with the Gallatin NF. The area contains a number of high, craggy peaks covered in talus, scree, and boulders. Vegetation on the upper ridges is mostly alpine and lacks forest cover. Glaciation has imparted many of these landforms with sharp and scoured edges. The vegetation includes lodgepole pine, subalpine fir, Engelmann spruce, and Douglas-fir forests as well as dry grasslands, whitebark pine forest, and limber pine. Small amounts of shrublands and juniper are also present.
Current uses and management	This area is in the Crazy Mountains inventoried roadless area. There are no open roads or motorized trails; the entire area is available for primitive and semi-primitive nonmotorized recreation use in the summer. There are 23.5 miles of nonmotorized trails. Motorized over-snow uses are currently allowed in 4,754 acres; the remainder of the area is available for primitive and semi-primitive non-motorized recreation in the winter.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no open roads or motorized trails, but motorized over-snow uses are currently allowed in a portion of the area. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hiking, horseback riding, hunting, fishing, dispersed camping, and wildlife viewing. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. The opportunity for solitude is diminished in the winter where over-snow motorized use is allowed. **Other Features of Value** – Features of this area include bare, rocky and high mountain peaks; and rare plant and animal species such as whitebark pine and harlequin duck.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is within the Crazy Mountains inventoried roadless area. The land to the north of the polygon is checkerboard ownership that is busy during hunting season. There are no private land inholdings. There are no open roads or motorized trails. Approximately 4,754 acres are available for motorized over-snow use; this use, along with mechanized means of transport on 23.5 miles of nonmotorized trail, would be discontinued under alternative D.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s)	o Outstanding opportunities for solitude o High interest exists for this area based on public comment. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.

Analysis Criteria	Description
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for hiking, horseback riding, hunting, fishing, dispersed camping, and wildlife viewing.

Blackfoot Meadows/Electric Peak Recommended Wilderness Area

The Electric Peak RWA is included in the 1986 Helena NF Plan. The area description is based on the Blackfoot Meadows wilderness inventory description, Divide 3 (D3). This area is included as a RWA in alternative A, as well as in alternatives B, C, and D under the name "Blackfoot Meadows". The boundary delineation for this area is slightly different for alternatives A, B/C, and D.

Table 7. Blackfoot Meadows recommended wilderness area

Analysis Criteria	Description
Acres	16,657 (alternative A); 18,296 acres (alternatives B, C); 26,900 acres (alternative D)
Description of the recommended boundary, alternative A	This RWA follows the HLC NF Boundary to complete the west, south and southeast portion of the boundary. The east boundary follows the base of Bison Mountain and traverses the ridgeline north to the confluence of Little Blackfoot River and Ontario Creek. The boundary follows the Little Blackfoot River to the east to complete the area.
Description of the recommended boundary – alternative B, C	The RWA follows the HLC NF Boundary to the west, south and southeast portion of the boundary. The east boundary follows the ridge of Bison Mountain and traverses Ontario Creek north to the confluence of the Little Blackfoot River and Ontario Creek. The boundary follows the Little Blackfoot River to the east of trail 227-009 and the HLC NF boundary to complete the area.
Description of the recommended boundary, alternative D	The RWA's western boundary follows a private property parcel, ridgeline and Baldy Ridge Trail and continues south following the HLC NF boundary to complete the west, south and southeast portion of the boundary. The east boundary follows the ridgeline to Ontario Creek north to the Monarch Creek and buffering Ontario Creek and Ontario Creek Road. The boundary buffers the Little Blackfoot River and Kading Campground to the south and the confluence of Ontario Creek and Little Blackfoot River to complete the area.
Description of the geography, topography, and vegetation	This RWA is located in the Divide GA. Portions of this RWA were identified as the Electric Peak RWA in the current 1986 Helena NF Plan. The Blackfoot Meadows RWA is not the same acreage or configuration as the Electric Peak RWA. Blackfoot Meadows RWA lies along the Continental Divide National Scenic Trail and includes several mountain peaks that are well over 8000 feet in elevation. Vegetation is dominated by lodgepole pine forests, with Douglas-fir also common as well as subalpine fir and Engelmann spruce. Less common vegetation types include grasslands, shrublands, and whitebark pine forests.
Current uses and management	Much of the area has been managed as a RWA since 1986. The entire polygon is available for non-motorized summer and winter recreation. Under alternative B/C, there are no open roads or motorized trails, but approximately 11 acres within the polygon is available for motorized over-snow uses. There are 16.3 miles of nonmotorized trail. Under alternative D, there are 2.4 miles of motorized trails. 4,754 acres are open to motorized over-snow use. There are 23.5 miles of nonmotorized trails.

Analysis Criteria	Description
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized trails or roads, and minimal motorized over-snow use. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: horseback riding, hiking, hunting, fishing, mountain biking, and camping. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. The opportunity for solitude is somewhat diminished in portions closest to Highway 12 and where the Little Blackfoot road is visible. **Other Features of Value** –Features of this area include the Little Blackfoot eligible wild and scenic river; cultural resources; and rare plant and animal species such as whitebark pine, grizzly bear, lynx, bull trout, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because the area has been managed as a RWA since 1986, and is adjacent to the Electric Peak RWA on the adjacent Beaverhead-Deerlodge NF. It is also within the Electric Peak inventoried roadless area. There is only one private inholding, along the Little Blackfoot road. Under alternatives B/C, there are currently no motorized trails or open roads, but a small area is available for over-snow motorized use. This use would be discontinued with alternative B but allowed with alternative C. Mechanized uses on non-motorized trails would be discontinued in alternative B but allowed to continue in alternative C. Motorized uses as well as mechanized means of transport would be discontinued under alternative D.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Most of the area was previously included as a RWA in the 1986 Helena NF Plan. o Outstanding opportunities for solitude. o High interest exists for this area to be recommended for wilderness. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o There are no motorized trails or open roads. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for horseback riding, hiking, hunting, fishing, mountain biking, and camping.

Colorado Mountain Recommended Wilderness Area

This RWA is derived from portions of the Colorado Mountain wilderness inventory polygon, Divide 5 (D5). It is included only in alternative D.

Table 8. Colorado Mountain recommended wilderness area

Analysis Criteria	Description
Acres	14,189 acres (alternative D)

Analysis Criteria	Description
Description of the recommended boundary	The Colorado Mountain RWA's eastern boundary follows irregular private property parcels and buffers Grizzly Gulch Road to the northeast. The northern boundary then follows the GA boundary. The southern boundary follows Rimini Road and borders existing private property parcels The southern boundary follows Rimini Road to Chessman Road and buffering Chessman Reservoir to complete the area. There are two small private inholding parcels within the interior of the larger area that the boundary excludes.
Description of the geography, topography, and vegetation	Colorado Mountain RWA is located in the upper reaches of the Colorado Gulch drainage in the Divide GA, southwest of Helena, Montana. The busy, dispersed recreation area known as the South Hills is located to the east. This RWA contains Black Mountain and Colorado Mountain. Douglas-fir forests are the most common vegetation type. Lodgepole pine forests are also common, with small amounts of dry grasslands, mesic grasslands, shrublands, ponderosa pine, subalpine fir, Engelmann spruce, cottonwood, and aspen.
Current uses and management	This area is in Lazyman Gulch inventoried roadless area. There are no open roads or motorized trails; the entire polygon is available for primitive and semi-primitive non-motorized recreation in the summer. A portion of the area (1,240 acres) is open for motorized over-snow uses; the remainder of the area is available for primitive and semi-primitive nonmotorized recreation in the winter. There are 1.9 miles of nonmotorized trail.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no open roads or motorized trails. A small portion of the area is open for motorized over-snow uses. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hiking, horseback riding, snowshoeing, cross country skiing, mountain biking, and hunting. **Solitude** – There is outstanding opportunity for solitude in most of the polygon as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. This opportunity is diminished where Highway 12 can be heard; where the residential area in Colorado Gulch may be seen and heard; and where over-snow motorized uses occur in the winter. **Other Features of Value** – Features of this area include Black Mountain and Colorado Mountain; Helena, Rimini, and Clancy Historic Mining Districts; historic Red Mountain Flume; municipal watershed for the city of Helena; and rare plant and animal species such as grizzly bear, lynx, flammulated owl, and wolverine.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is within Lazyman Gulch inventoried roadless area. However, there are 2 private land inholdings; the northern boundary is adjacent to private land; and the western boundary is adjacent to a superfund site. There are no open roads or motorized trails; however motorized over-snow use is allowed in a portion of the area. This use, along with mechanized means of transport on nonmotorized trails, would be discontinued under alternative D.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Opportunities for solitude. o High interest exists for this area based on public comment. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.

Analysis Criteria	Description
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for hiking, horseback riding, snowshoeing, cross country skiing, mountain biking, and hunting.

Deep Creek Recommended Wilderness Area

This RWA is derived from the Deep Creek Tenderfoot wilderness inventory area, Little Belts 1a (LB1a). It is included in alternatives B, C, and D with the exact same boundary.

Table 9. Deep Creek recommended wilderness area

Analysis Criteria	Description
Acres	14,490 acres (alternatives B, C, and D)
Description of the recommended boundary	The Deep Creek RWA follows the Cascade and Meagher County boundaries to complete the northern section of the boundary. The boundary buffers the Smith River completing the western portion of the boundary section. The south and eastern portion of the boundary follows the existing ridgeline to complete the area.
Description of the geography, topography, and vegetation	Deep Creek RWA is located in the northwestern corner of the Little Belts GA. This area is bordered by the Smith River on the west, private lands to the north and south, and by motorized national recreation trails to the south and east. The primary access to this area is from the Smith River, private lands, and from motorized national recreation trails. Existing vegetation is dominated by Douglas-fir and lodgepole pine. Dry grasslands and subalpine fir/Engelmann spruce forests are also common, with some ponderosa pine. Small amounts of other types are present, including shrublands, whitebark pine, limber pine, cottonwood, aspen, and juniper.
Current uses and management	The area lies in the Tenderfoot- Deep Creek inventoried roadless area. There are currently no motorized recreation uses or open roads within the Deep Creek RWA. There are 12.9 miles of non-motorized trail.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are currently no motorized uses. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: Hunting, fishing, backpacking, horseback riding, boating on the Smith River, and mountain biking. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. **Other Features of Value** – Features include the eligible wild and scenic Smith River;; cultural resources; and rare species such as whitebark pine, lynx, wolverine, and westslope cutthroat trout.

Analysis Criteria	Description
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is a large polygon adjacent to NFS lands to the east and south. There is only one private inholding, along Deep Creek Park. There are no motorized uses. Mechanized uses on nonmotorized trails would be discontinued in alternative B, but allowed in alternative C.
A summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o High interest exists for this area to be recommended for wilderness. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high as there are currently no motorized recreation uses. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for hunting, fishing, backpacking, horseback riding, boating on the Smith River, mountain biking.

Tenderfoot Creek Recommended Wilderness Area

This RWA is derived from the Deep Creek Tenderfoot Creek wilderness inventory polygon, Little Belts 1b (LB1b). It is included only in alternative D.

Table 10. Tenderfoot Creek recommended wilderness area

Analysis Criteria	Description
Acres	45,870 acres (alternative D)
Description of the recommended boundary	The Tenderfoot RWA consists of four parcels. The three smaller parcels follow the boundary of three small inholdings within the interior of the larger parcel. The eastern boundaryof the large parcel buffers Williams Mountain Trail, Lost Stove Trail and Lost Stove Road northeast. The northern boundary buffers the Divide Road, Balsinger to Taylor trail, Monument Ridge Road and Old Baldy trail to the northwest. The northwest boundary buffers Smart Fork Trail, bordering a private property parcel and Simmons Park Road. The western boundary borders a private property parcel and the GA boundary. The southern boundary follows Tenderfoot Trail and borders a private property parcels to the southeast. The boundary then follows Tenderfoot Creek and a private property parcel to the southeast. The boundary buffers Williams Park Road to complete the area.
Description of the geography, topography, and vegetation	The Tenderfoot Creek RWA is located within the Tenderfoot Creek drainage in the Little Belt Mountains GA. Existing vegetation is dominated by Douglas-fir and lodgepole pine. Dry grasslands and subalpine fir/Engelmann spruce forests are also common, and some ponderosa pine is present. Very small amounts of other types are also present, including shrublands, whitebark pine, limber pine, cottonwood, aspen, and juniper.
Current uses and management	The area lies within the Tenderfoot- Deep Creek inventoried roadless area. There are no open roads, but 5.9 miles of motorized trail are present and 5,872 acres open to motorized over-snow motorized use; primitive and semi-primitive nonmotorized recreation opportunities are provided in the remainder of the area in the summer and winter respectively. There are also 29.7 miles of nonmotorized trail.

Analysis Criteria	Description
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no open roads, but motorized trails are currently present along with some areas open to motorized over-snow use. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hunting, fishing, backpacking, horseback riding, and mountain biking. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. **Other Features of Value** – Features of this area include the waterfalls on Tenderfoot Creek; Tenderfoot Creek eligible wild and scenic river; cultural resources; and rare plant and animal species such as whitebark pine, lynx, wolverine, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is a large polygon adjacent to NFS lands to the east and south. There are some motorized summer and over-snow uses as described above. These uses, along with mechanized uses on nonmotorized trails, would be discontinued in alternative D.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o High interest exists for this area to be recommended for wilderness. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is high. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for hunting, fishing, backpacking, horseback riding, mountain biking.

Big Horn Thunder Recommended Wilderness Area

This RWA is derived from the Big Horn Thunder wilderness inventory polygon, Little Belts 2 (LB2). It is included only in alternative D.

Table 11. Big Horn Thunder recommended wilderness area

Analysis Criteria	Description
Acres	47,107 acres (alternative D)

Analysis Criteria	Description
Description of the recommended boundary	The Big Horn Thunder RWA consists of four parcels. The small three parcels follow the boundary of three small inholdings within the larger parcel. The eastern boundary of the large parcel follows private property section boundaries north and continues to follows private property parcels to the north and northwest. The western boundary borders private property parcels and buffers Divide Road to the southwest. The southwest boundary continues to buffer Long Coulee Trail and buffering Divide Road bordering a private property parcel to the south and southeast to complete the area.
Description of the geography, topography, and vegetation	The Bighorn Thunder RWA is located east of Logging Creek and north of the Divide Road in the Little Belt Mountains GA. It contains the high mountain peaks of Big Horn Mountain and Thunder Mountain. Pilgrim Creek runs north-south and bisects the area. The most common vegetation types are Douglas-fir and lodgepole pine forests, with some subalpine fir and Engelmann-spruce at higher elevations. Minor amounts of other types also occur, including dry grasslands, sparsely vegetated areas (rock and scree), ponderosa pine, shrublands, whitebark pine, limber pine, cottonwood, and aspen.
Current uses and management	This area is within the Pilgrim Creek inventoried roadless area. There are 2.6 miles of open road. There are also 3 motorized trails open seasonally (summer) to motorcycles, totaling 15.7 miles. The areas east and west of the Pilgrim Creek Trail are available for primitive and semi-primitive non-motorized summer recreation. There are 11.2 miles of nonmotorized trail. There is a snowmobile corridor along the boundary with FS road 839 totaling 2,308 acres; the remainder of the polygon is available for primitive and semi-primitive non-motorized recreation in the winter.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. Motorized uses currently occur on open roads, motorized trails, and in areas open to motorized over-snow use. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: horseback riding, fishing, archery, rifle hunting, and mountain biking. **Solitude** – There is outstanding opportunity for solitude in most of the polygon as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. This opportunity is diminished where motorized uses are allowed. **Other Features of Value** – Features of this area include Big Horn Mountain, Thunder Mountain, Pilgrim Creek, Tillinghast Creek, and rock scree under Thunder Mountain; cultural resources; and rare species such as whitebark pine and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is within the Pilgrim Creek inventoried roadless area. There are 2 private inholdings, and recreation residences along the periphery. Under alternative D, motorized use on open roads, motorized trails, and in areas open to motorized over-snow use would be discontinued, along with mechanized means of transport.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o High interest exists for this area based on public comment.

Analysis Criteria	Description
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is high. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for horseback riding, fishing, archery, rifle hunting, and mountain biking.

Middle Fork Judith Recommended Wilderness Area

This RWA is derived from portions of the Middle Fork Judith wilderness inventory polygon, Little Belts 16 (LB16). It also includes portions of the Middle Fork Judith Wilderness Study area. It is only included in alternative D.

Table 12. Middle Fork Judith recommended wilderness area

Analysis Criteria	Description
Acres	62,452 acres (alternative D)
Description of the recommended boundary	The Middle Fork Judith RWA's eastern boundary buffers the Ettien Ridge Trail northwest following the Middle Fork Judith River and a private property parcel. The eastern boundary then buffers Schaeffer Ridge Trail, Woodchopper Ridge Trail, Morris Creek Trail and Yogo Creek Road. The northern boundary follows private property parcels and buffers Dry Wolf Road northwest. The western boundary buffers Dry Wild Road to the west. The southwestern boundary borders patented mining claims south on the existing ridgeline and buffering Sand Point Road. The boundary continues southwest following the North Fork of the Musselshell River Divide Road to the southwest. The southern boundary buffers Burnt Ridge Road and existing ridgeline to complete the area.
Description of the geography, topography, and vegetation	The Middle Fork Judith RWA is located in the Little Belt Mountains GA. It includes the lower Lost Fork and Middle Fork of the Judith River with the major high points being Yogo Peak, Cabin Mountain, Grendah Mountain, Sandpoint Mountain, and Lost Fork Ridge. The most common vegetation types consist of Douglas-fir, subalpine fir, Engelmann spruce, and lodgepole pine forests. Dry grasslands also occur, along with limber pine, shrublands, ponderosa pine, rock/scree, and whitebark pine. Several large fires have occurred in this area recently.
Current uses and management	The majority of this area is in the Middle Fork Judith wilderness study area; and is in within Middle Fork Judith inventoried roadless area. There are 0.7 miles of open road, but no motorized trails. In addition, about 4,996 acres are open to motorized over-snow use (the outer perimeter of the polygon). There are 56 miles of nonmotorized trails. The majority of the area is available for primitive and semi-primitive nonmotorized recreation in both summer and winter. The Russian Flats airstrip is located near the polygon.

Analysis Criteria	Description
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are 0.7 mile of open road and approximately 4,996 acres open to motorized over-snow recreation uses. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: horseback riding, fishing, hunting, mountain biking, dispersed camping, cross country skiing, and snowshoeing outfitting. **Solitude** – There is outstanding opportunity for solitude in most of the polygon as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. This opportunity is diminished in proximity to the Russian Flats airstrip, and where motorized uses are allowed. **Other Features of Value** – Features of this area include the Middle Fork Judith River; Yogo Peak; cultural resources; Judith River eligible Wild and Scenic River; and rare plant and animal species such as wolverine, black rosy finch, western toad, dwarf shrew, whitebark pine and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it has been managed as a Wilderness Study Area since 1977. Existing motorized use as well as mechanized means of transport would be discontinued with alternative D.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o The majority of the area has been a wilderness study act area since 1977. o Outstanding opportunities for solitude. o High interest exists for this area based on public comment. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for horseback riding, fishing, hunting, mountain biking, dispersed camping, cross country skiing, and snowshoeing outfitting in the fall.

Big Snowies Recommended Wilderness Area

This RWA is derived from the Big Snowies wilderness inventory area, Snowies 1 (S1). It includes all lands designated as the Big Snowies Wilderness Study area. It is included in alternatives B, C, and D with the exact same boundary.

Table 13. Big Snowies recommended wilderness area

Analysis Criteria	Description
Acres	95,299 acres (alternatives B, C, and D)

Analysis Criteria	Description
Summarized description of the recommended boundary	The Big Snowies RWA follows the GA boundary for the east boundary. The northern boundary follows the North GA boundary and buffers Crystal Lake Road and the Crystal Lake Recreational area. The boundary then follows the geographic administrative boundary to complete the northern boundary. The east boundary follows the GA boundary. The Southern boundary buffers the Neil Connection Trail 653 to bordering a private property parcel and following the existing ridgeline to the southwest. The boundary then parallels private property to the southwest and follows the GA boundary to complete the area.
Description of the geography, topography, and vegetation	This RWA encompasses the majority of the island mountain range of the Big Snowies, and is dominated by limestone geology and karst topography which conceals many caves including an ice cave on West Peak. The RWA is also characterized at its highest elevations by a tree-less plateau of alpine with rock and tundra. The dominant vegetation includes Douglas-fir, lodgepole pine, subalpine fir and Engelmann spruce forests. Sparsely vegetated areas (such as rock/scree) are also found along with grasslands, whitebark pine, and very small occurrences of shrublands, ponderosa pine, limber pine, cottonwood, and aspen.
Current uses and management	This area has been managed as a wilderness study area since 1977 and is lies within the Big Snowies inventoried roadless area. It contains several research natural areas. The area is popular with mountain bike users in the summer and snowmobile users in the winter months. The southern portion of the polygon is open to motorized use in the summer, containing 11.8 miles of open road and 0.1 miles of motorized trail. Primitive and semi-primitive non-motorized recreation opportunities are provided in the entire polygon north of Trails 652 and 653 in the summer. There are 98.3 miles of nonmotorized trail in the polygon. Winter motorized recreation is allowed on 13,145 acres.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention; however there are some motorized uses associated with open roads in the summer and over-snow uses in portions of the area in the winter. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: Hiking, horseback riding, dispersed camping, back country skiing, fishing, mountain biking, caving, and hunting. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. The opportunity for solitude is diminished in portions of the polygon that contain motorized trails (area north of Trails 653 and 653 in the summer; and where snowmobiles are allowed in the winter in the western portion of the polygon). **Other Features of Value** – Features of this area include an introduced population of mountain goats; cirque basins in Careless Creek and Swimming Woman Creek; ice caves; several research natural areas; Swimming Woman eligible Wild and Scenic River; municipal watershed for Lewistown; cultural resources; and rare plant and animal species such as *Goodyera repens,* whitebark pine, lynx, dwarf shrew, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it has been managed as a wilderness study area since 1977 and covers the majority of the island mountain range of the Big Snowies. There is some private land adjacent to the polygon. There are some motorized summer and over-snow uses as described above. These uses, along with mechanized uses on nonmotorized trails, would be discontinued in alternative B, but allowed in alternative C.
A brief summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Designation as a wilderness study act area o Outstanding opportunities for solitude; very remote area. o High interest exists for this area to be recommended for wilderness.

Analysis Criteria	Description
Brief summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high as the majority of this area is un-roaded. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for hiking, horseback riding, dispersed camping, back country skiing, fishing, mountain biking, caving, and hunting.

Dearborn Silverking Recommended Wilderness Area

This RWA is derived from the Dearborn Silverking wilderness inventory area, Upper Blackfoot 1 (UB1). It is included in alternatives B, C, and D with the exact same boundary.

Table 14. Dearborn Silverking recommended wilderness area

Analysis Criteria	Description
Acres	20,088 acres (alternatives B, C, and D)
Summarized description of the recommended boundary	The Dearborn Silverking RWA's east boundary buffers Alice Creek road 293 and buffering Lewis and Clark Pass Trail 493. The east boundary then borders a private property section and existing GA boundary to the northeast. The northern boundary follows the ridgeline to the Continental Divide trail and following the Bob Marshall Wilderness boundary. The eastern boundary section continues to follow the Bob Marshall Wilderness boundary south. The southern boundary follows the ridgeline and buffers the Indian Meadows Trailhead and Guard Station. The boundary then borders a private property parcel and follows the GA boundary to complete the area.
Brief description of the general geography, topography, and vegetation	The Dearborn Silverking RWA is located in the Upper Blackfoot and Rocky Mountain Range GAs north and east of Lincoln, Montana, and lies adjacent to the Scapegoat Wilderness Area in the upper reaches of the Alice Creek and Landers Fork drainages. The area is dominated by Douglas-fir and lodgepole pine forests, with dry grasslands, subalpine fir forests, and small amounts of Engelmann spruce, whitebark pine, limber pine, cottonwood, aspen, and Rocky Mountain juniper. Wildfire disturbances have been prominent in this polygon.
Current uses and management	This area is adjacent to the Scapegoat Wilderness, and within the Silver King-Falls Creek inventoried roadless area. A portion is also within the Rocky Mountain Front Conservation Management Area. It contains one research natural area. There are no motorized trails or open roads; the entire polygon is available for primitive and semi-primitive non-motorized summer recreation. There are 20.8 miles of nonmotorized trail. Most of the area is available for primitive and semi-primitive non-motorized winter recreation, except for 17 acres which are open for motorized over-snow uses.

Analysis Criteria	Description
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized uses except for a small area where over-snow motorized use is allowed in the winter. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: Hunting, fishing, hiking, horseback riding, dispersed camping, snowshoeing, and cross country skiing. Historic interpretation along the upper portions of Alice Creek, Landers Fork and in the Lewis and Clark pass area. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. Solitude is slightly diminished in close proximity to the Alice Creek road. **Other Features of Value** – Features of this area include the Alice Creek National Registered Historic District, the Lewis and Clark National Historic Trail; Limestone Reef caves; Blowout Mountain and Flattop; waterfalls on Falls Creek; many historic and cultural resources; Alice and Landers Fork eligible Wild and Scenic Rivers; and rare plant and animal species such as grizzly bear, western toad, fisher, trumpeter swan, whitebark pine, lynx, bull trout, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is adjacent to the Scapegoat Wilderness, lies within an inventoried roadless area as well as partly in a Conservation Management Area. There are no private inholdings. There are currently no motorized trails or open roads, but a small area is available for over-snow motorized use. This use along with mechanized uses on non-motorized trails would be discontinued with alternative B but allowed with alternative C.
A brief summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude; very remote area. o Adjacent to the Scapegoat Wilderness area. o High interest exists for this area to be recommended for wilderness. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species, including Canada lynx and grizzly bear.
Brief summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high and there are no motorized trails. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for hunting, fishing, hiking, horseback riding, dispersed camping, snowshoeing, and cross country skiing as well as historic interpretation along the upper portions of Alice Creek, Landers Fork and in the Lewis and Clark pass area.

Red Mountain Recommended Wilderness Area

This RWA is derived from the Red Mountain wilderness inventory area, Upper Blackfoot 2a (UB2a). It is included in alternatives B, C, and D with the exact same boundary.

Table 15. Red Mountain recommended wilderness area

Analysis Criteria	Description
Acres	1,901 acres (alternatives B, C, and D)

Analysis Criteria	Description
Description of the recommended boundary	The Red Mountain RWA's northern boundary follows The Bob Marshall Wilderness boundary to the west to over the ridgeline of Red Mountain peak and the existing ridgeline to the southwest. The southeast boundary follows the Red Creek drainage and section line 1 to make the south and southeast portion. The east boundary follows the private property section to complete the area.
Description of the general geography, topography, and vegetation	The Red Mountain RWA is locate south and east of Red Mountain Peak in Red Creek, within the Copper Creek drainage. This area is characterized by subalpine fir, Engelmann spruce, Douglas-fir, and lodgepole pine forests with a small amount of whitebark pine, ponderosa pine and limber pine. Much of this area has been recently impacted by wildfire and some is in a non-forested or newly reforested state.
Current uses and management	This area is adjacent to the Scapegoat Wilderness, the area is within the Bear-Marshall - Scapegoat–Swan inventoried roadless area. It is a research natural area which is managed. There are no open roads or motorized trails, and no motorized over-snow uses, the entire polygon is available for primitive and semi-primitive non-motorized recreation. There is less than 0.1 miles of nonmotorized trail.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized uses or open roads. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hunting, fishing, hiking, horseback riding, mountain biking, and dispersed camping. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. **Other Features of Value** – Features of this area include the Copper Lakes; the Lincoln Historic Mining District; a research natural area; Snowbank and Copper Creek eligible Wild and Scenic Rivers; and rare plant and animal species such as grizzly bear, whitebark pine, lynx, bull trout, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because it is adjacent to the Scapegoat Wilderness, has been managed as a research natural area since 1986, and there are no motorized uses in the area. There is one patented mining claim in the polygon. There is one very short segment (<0.1 miles) of nonmotorized trail; mechanized use of this trail would be discontinue in alternative B but allowed in alternative C.
A summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o Adjacent to the Scapegoat Wilderness area. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species, including Canada lynx and grizzly bear.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high because the area is un-roaded and there are no motorized uses. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude. o There is high amount of primitive and/or unconfined recreation for hunting, fishing, hiking, horseback riding, mountain biking, and dispersed camping.

Arrastra Creek Recommended Wilderness Area

This RWA is derived from the Arrastra wilderness inventory area, Upper Blackfoot 2b (UB2b). It is included in alternatives B, C, and D with the exact same boundary.

Table 16. Arrastra recommended wilderness area

Analysis Criteria	Description
Acres	8,257 acres (alternatives B, C, and D)
Description of the recommended boundary	The Arrastra RWA's northern boundary follows The Bob Marshall Wilderness boundary to the west over the ridgeline of Arrastra Mountain peak and the existing ridgeline to the southwest. The western boundary traverses the Meadow Creek trail and a Montana State land section. The southern boundary buffers Beaver Creek - Dry Creek road extending to Upper Beaver Spur Road. The east boundary follows the Klondike Creek drainage and existing ridgeline to complete the area.
Description of the geography, topography, and vegetation	The Arrastra Creek RWA is located in the Upper Blackfoot GA north and west of Lincoln, Montana, and lies adjacent to the Scapegoat Wilderness Area in the upper reaches of the Beaver Creek and Dry Creek drainages. It includes Arrastra Mountain. This area is characterized by subalpine fir, Engelmann spruce, Douglas-fir, and lodgepole pine forests with a small amount of whitebark pine, ponderosa pine and limber pine.
Current uses and management	This area is adjacent to the Scapegoat Wilderness, within the Bear - Marshall - Scapegoat – Swan inventoried roadless area. There are no open roads or motorized trails, and therefore the area is available for primitive or semi-primitive nonmotorized recreation in the summer. There are 7.9 miles of nonmotorized trails. There are 2,239 acres that are open to motorized over-snow use; the remainder of the area is available for primitive or semi-primitive nonmotorized recreation in the winter.
Description of the wilderness characteristics and the ability to protect and manage the area so as to preserve its wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no open roads or motorized trails, but a portion of the area does allow motorized over-snow use. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hunting, fishing, hiking, horseback riding, mountain biking, and dispersed camping. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. These opportunities are diminished in the winter where motorized use is allowed. **Other Features of Value** – Features include; the Lincoln Historic Mining District; a research natural area, rare plant and animal species such as grizzly bear, whitebark pine, lynx, bull trout, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because the area is adjacent to the Scapegoat Wilderness. There are currently no motorized trails or open roads, but there is some motorized over-snow use allowed in portions of the area in the winter. This use, along with mechanized use on 7.9 miles of nonmotorized trails, would be discontinued with alternative B, but allowed with alternative C.
Summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o Adjacent to the Scapegoat Wilderness area. o High interest exists for this area to be recommended for wilderness. o The location and configuration of this RWA helps maintain or enhance habitat connectivity for large, wide-ranging wildlife species, including Canada lynx and grizzly bear.

Analysis Criteria	Description
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high because the area is un-roaded. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for hunting, fishing, hiking, horseback riding, mountain biking, and dispersed camping.

Nevada Mountain Recommended Wilderness Area

This RWA is derived from the Nevada Mountain wilderness inventory area, Upper Blackfoot 10 (UB10). It is included in alternatives B, C, and D. The boundary delineation for this area is slightly different for alternative D as compared to alternatives B and C.

Table 17. Nevada Mountain recommended wilderness area

Analysis Criteria	Description
Acres	39,345 acres (alternatives B, C); 44,7012 acres (alternative D)
Description of the recommended boundary (alternatives B/C)	The RWA's northeastern boundary traverses the Helmville-Gould pack trail and a segment of the Continental Divide National Scenic Trail north following Poorman Creek to the northwest bordering patented mining claims. The western boundary follows the McClellan Gulch to the Helmville-Gould pack trail and existing ridgeline to Huckleberry Creek west. The southwestern western boundary then buffers Nevada Creek Road and a private property land parcel to the southwest following the Geographic area boundary. The southern boundary follows the Black Mountain ridgeline and follows the Continental Divide over the ridge of Myers Hill. The southeast boundary follows the ridgeline to the South Fork of Little Prickly Pear Road, the ridgeline and buffering Mcquithy Gulch Road bordering a private property parcel. The boundary continues Northeast on the ridgeline crossing the Helmville-Gould pack trail and a segment of the Continental Divide National Scenic Trail to complete the area.
Description of the recommended boundary (alternative D)	The RWA consists of two parcels. The large parcels northeastern boundary traverses the Helmville-Gould pack trail and a segment of the Continental Divide National Scenic Trail north following Poorman Creek to the northwest bordering patented mining claims. The western boundary follows the McClellan Gulch to the Helmville-Gould pack trail and existing ridgeline to Huckleberry Creek west. The southwestern western boundary then buffers Nevada Creek Road and a private property land parcel to the southwest following the Geographic area boundary. The southern boundary follows the Black Mountain ridgeline and follows the Continental Divide over the ridge of Myers Hill. The southeast boundary follows the ridgeline to the South Fork of Little Prickly Pear Road, the ridgeline and buffering Mcquithy Gulch Road bordering a private property parcel. The boundary continues Northeast on the ridgeline crossing the Helmville-Gould pack trail, bordering a segment of the Continental Divide National Scenic Trail bordering a private inholding and following the Geaographic area boundary to complete the area. The small parcel section borders a patented mining claim section to complete the area.
Description of the geography, topography, and vegetation	Nevada Mountain RWA is located south and west of Lincoln, Montana in the Upper Blackfoot and Divide GAs. It includes Nevada Mountain, Black Mountain, and the head end of many drainages such as Nevada Creek and Washington Creek, as well as several smaller drainages that flow into Poorman Creek. The area straddles the continental divide, and portions of the Continental Divide National Scenic Trail cross through it. This area is characterized by lodgepole pine forests, along with Douglas-fir, subalpine fir, Engelmann spruce, and dry grasslands. Less common types are present include shrublands, whitebark pine, limber pine, cottonwood, and aspen. There are some sparsely vegetated areas as well (scree/rock).

Analysis Criteria	Description
Current uses and management	This area is in Nevada Mountain inventoried roadless area. There is active mining in the polygon. In alternatives B/C, there are no open roads or motorized trails; the entire polygon is available for primitive and semi-primitive non-motorized summer recreation. 8,878 acres south of Jefferson Creek are open to motorized over-snow use; the remainder of the area is available for primitive and semi-primitive non-motorized recreation in the winter. There are 30.5 miles of nonmotorized trails. In alternative D, there are 1.3 miles of open roads and 3.4 miles of motorized trails. 13,099 acres are open to motorized over-snow use. There are 31.2 miles of nonmotorized trails.
Description of the wilderness characteristics	**Natural Quality** – The majority of this area is very natural appearing and the current vegetation is primarily affected by natural ecological processes. Most of this area has intact ecological integrity and generally appears to reflect ecological conditions that would be associated with the area without human intervention. **Undeveloped** – The majority of this area is undeveloped and not affected by human intervention. There are no motorized trails or open roads within the area. **Unconfined and/or primitive recreation** – This area has an outstanding amount of unconfined and primitive recreation opportunities: hunting, hiking (including the Continental Divide National Scenic trail), horseback riding, and mountain biking. **Solitude** – There is outstanding opportunity for solitude as the sights and sounds of human activities and improvements are screened by topography or do not have impact due to distance. These opportunities are diminished in the winter in areas where motorized use is allowed. **Other Features of Value** – Features of this area include Nevada Mountain, Black Mountain, and open scenic ridges along the Continental Divide National Scenic Trail; cultural resources; and rare plant and animal species such as grizzly bear, whitebark pine, lynx, bull trout, and westslope cutthroat trout.
The ability to protect and manage the area so as to preserve its wilderness characteristics	The ability to protect and manage these wilderness characteristics is high because the RWA is within Nevada Mountain inventoried roadless area. There are patented mining claims and access road inholdings in the polygon. In alternatives B/C, there are no motorized trails or open roads; however over-snow motorized use is allowed on a portion of the area. This use, along with mechanized use on nonmotorized trails, would be discontinued under alternative B but allowed in alternative C. Motorized uses as well as mechanized means of transport would be discontinued under alternative D.
A summary of the factors considered and the process used in evaluating the area and developing the alternative(s).	o Outstanding opportunities for solitude. o Aligns with the management of the Continental Divide National Scenic Trail. o High interest exists for this area to be recommended for wilderness, including collaborative comments from diverse stakeholders. o The location and configuration is in an area important for habitat connectivity for large, wide-ranging wildlife species, including Canada lynx and grizzly bear.
Summary of the ecological and social characteristics that would provide the basis for suitability for inclusion in the National Wilderness Preservation System	The ecological characteristics that provide the basis for suitability include: o The naturalness of the area is very high as much of the area is affected primarily by natural forces, has mostly intact ecological integrity and contains many indigenous species. o The undeveloped quality of the area is very high because the area is un-roaded. The social characteristics that provide the basis for suitability include: o The area offers outstanding opportunity for solitude o There is high amount of primitive and/or unconfined recreation for hunting, hiking (including the Continental Divide National Scenic trail), horseback riding, and mountain biking.

Rationale for Including or Excluding Wilderness Inventory Polygons from DEIS Alternatives

The reasons for excluding wilderness inventory polygons, or portions thereof, from further analysis in one or more alternative in the DEIS are documented in the following table. For maps of all wilderness inventory polygons are provided in appendix F of the Draft Plan.

Table 18. Summary of wilderness evaluation with rationale for inclusion as recommended wilderness by alternative

GA	Wilderness Inventory Polygon Name	Wilderness Inventory Polygon Number	Wilderness Inventory Polygon Acres	Recommended Wilderness Acres Alternatives B and C	Recommended Wilderness Acres Alternative D	Recommendation/Rationale
Big Belts	Big Log	BB1	10,254	7,086	7,086	Recommended with modifications in alternatives B, C, and D because it is adjacent to the existing Gates of the Mountain wilderness and was recommended in 1986.
	Hogback	BB2	5,784	0	0	Not recommended due to motorized system roads and trails that affect opportunities for solitude.
	Trout Creek	BB3	39,383	0	0	Not recommended due to motorized system roads and trails that affect opportunities for solitude.
	North Belts	BB4	14,140	0	0	Not recommended due to motorized system roads and trails that affect opportunities for solitude.
	Bilk Mountain	BB5	25,787	0	0	Not recommended due to motorized system roads and trails that affect opportunities for solitude.
	Camas Creek	BB6	23,878	0	22,350	Not recommended in alternatives B/C because of resource management activities that would be inconsistent with wilderness characteristics. Recommended in alternative D due to public comment and ecological characteristics.
	Mount Baldy	BB7	18,335	8,314	8,314	Recommended with modifications in alternatives B, C, and D. Recommended in 1986. Provides outstanding opportunity for solitude.
	Grassy Mountain	BB8	6,194	0	0	Not recommended due to the effects to the wilderness characteristic of solitude from activities around Highway 12 and adjacent subdivision.
Castles	Wapiti Peak	CA1	33,002	0	30,606	Not recommended in alternatives B/C because of motorized trails that affect solitude and opportunities for primitive and semi-primitive nonmotorized recreation. Recommended in alternative D due to public comment and ecological characteristics.

GA	Wilderness Inventory Polygon Name	Wilderness Inventory Polygon Number	Wilderness Inventory Polygon Acres	Recommended Wilderness Acres Alternatives B and C	Recommended Wilderness Acres Alternative D	Recommendation/Rationale
	Whetstone Ridge	CA3	8,676	0	0	Not recommended due to motorized trails and activity that affect solitude and opportunities for primitive and semi-primitive nonmotorized in both summer and winter.
Crazies	Loco Mountain	CR1	25,605	0	24,977	Not recommended in alternatives B/C because checkerboard ownership and adjacent private lands affect FS ability to manage as wilderness and limit public access. Recommended in alternative D due to public comment and ecological characteristics.
	Bald Ridge	CR3	13,210	0	0	Not recommended due to motorized trails and activity that affect solitude and opportunities for primitive and semi-primitive nonmotorized in both summer and winter.
Divide	Sweeney Creek	D2	7,978	0	0	Not recommended because motorized activity outside of the polygon affects solitude.
	Blackfoot Meadows	D3	29,066	18,296	26,900	Recommended with modifications in alternatives B, C, and D because of outstanding opportunities for solitude; and the area was recommended in 1986.
	Colorado Mountain	D5	8,168	0	14,189	Not recommended in alternatives B/C due to proximity to private lands and population center that affect opportunities for solitude; and FS management that would be inconsistent with wilderness characteristics. Recommended in alternative D based on public comment and ecological characteristics.
	Continental Divide North	D13	4,173	0	0	Not recommended due the effects to wilderness solitude from communication sites, shooting range, Highway 12, Priest Pass road, and groomed snowmobile trails.
Elkhorns	Eagle Basin	E1	57,279	0	0	Not recommended because the Elkhorns GA is managed as a wildlife management unit.
	Elkhorn Peak	E3	15,180	0	0	Not recommended because the Elkhorns GA is managed as a wildlife management unit.
Highwood	Highwood Baldy	H1	15,824	0	0	Not recommended because wilderness characteristics are affected by electronics site and adjacent private lands; and there is a lack of public access.
	Arrow Prospect	H2	26,210	0	0	Not recommended because motorized trails in summer and winter affect solitude experience.

GA	Wilderness Inventory Polygon Name	Wilderness Inventory Polygon Number	Wilderness Inventory Polygon Acres	Recommended Wilderness Acres Alternatives B and C	Recommended Wilderness Acres Alternative D	Recommendation/Rationale
Little Belts	Deep Creek (Tenderfoot)	LB1	89,321	14,490	14,490	Most of the inventory polygon was not recommended due to motorized uses. The remainder was partitioned into LB1a and LB1b. In alternatives B, C, and D, LB1a (Deep Creek) is recommended based on outstanding opportunities for solitude and ecological characteristics. In alternative D, LB1b (Tenderfoot Creek) is recommended based on public comment and ecological characteristics.
				0	45,870	
	Big Horn Thunder	LB2	45,334		47,107	Not recommended in alternatives B/C because motorized use affects solitude. Recommended in alternative D based on public comment and ecological characteristics.
	Sun Mountain	LB3	7,965			Not recommended because open motorized roads, residential areas, and recreation areas impact solitude.
	McGee Sawmill	LB4	8,355			Not recommended because the Dry Fork Belt Creek road affects solitude.
	Peterson Mountain	LB5	6,839			Not recommended because activities on surrounding private land affect opportunities for solitude.
	Taylor Mountain	LB6	11,374			Not recommended because activities on surrounding private land affect opportunities for solitude.
	Big Baldy	LB8	49,068			Not recommended because motorized use throughout limits opportunities for solitude, plus impacts from historic mining.
	Eagle Creek	LB10	6,337			Not recommended because adjacent private land, checkerboard ownership, and motorized routes affect opportunities for solitude and manageability.
	Calf Creek	LB11	12,598			Not recommended because motorized trails and snowmobiling limit opportunities for solitude.
	North Fork Smith	LB15	9,817			Not recommended because surrounding motorized use and winter motorized access limit opportunities for solitude.
	Middle Fork Judith	LB16	98,312		62,452	Not recommended in alternatives B/C because motorized trails and private inholdings accessed by open roads impact solitude. Recommended in alternative D based on public comment and ecological characteristics.
	East Little Belts	LB18	106,178			Not recommended because motorized trails affect opportunities for solitude.

GA	Wilderness Inventory Polygon Name	Wilderness Inventory Polygon Number	Wilderness Inventory Polygon Acres	Recommended Wilderness Acres Alternatives B and C	Recommended Wilderness Acres Alternative D	Recommendation/Rationale
Rocky Mountain Range	Badger Two Medicine	RM1	125,795			Not recommended because existing Blackfeet Nation reserved rights may conflict with wilderness characteristics.
	Teton Blackleaf	RM2	56,002			Not recommended because solitude is affected by open roads and snow play area; and the area is a Conservation Management Area.
	Sun Canyon Willow	RM3	71,106			Not recommended because activities along Sun Canyon Road, Beaver Willow Road, Benchmark Road Area, and Mortimer Gulch area affect solitude; and the area is a Conservation Management Area.
	Sawtooth Ridge	RM4	15,312			Not recommended because of the effects to solitude from Sun Canyon and Beaver Willow roads; and the area is a Conservation Management Area.
	Elk Smith	RM5	30,030			Not recommended because motorized activities affect solitude, and the area a Conservation Management Area.
Snowies	Big Snowies	S1	103,480	95,299	95,299	Recommended with modifications in alternatives B, C, and D because the area is remote and has excellent opportunities for solitude.
Upper Blackfoot	Dearborn Silverking[1]	UB1	44,141	20,088	20,088	Recommended with modifications in alternatives B, C, and D because the area is adjacent to the Scapegoat Wilderness and has excellent opportunities for solitude.
	Stonewall (Red Mountain, Arrastra)	UB2	30,046	1,901	1,901	Most of the inventory polygon was not recommended due to motorized uses. The remainder was partitioned into UB2a and UB2b. In alternatives B, C, and D, UB2a (Red Mountain) and UB2b (Arrastra) are recommended because they are adjacent to the Scapegoat Wilderness and offer outstanding opportunities for solitude.
				8,257	8,257	
	Black Mountain	UB3	10,220			Not recommended because snowmobile use limits opportunities for solitude.
	Anaconda Hill	UB4	21,539			Not recommended because motorized uses near the polygon impact opportunities for solitude.
	Paige Gulch	UB5	17,569			Not recommended because motorized uses impact opportunities for solitude.
	Bear Gulch	UB9	5,636			Not recommended because motorized uses and patented mining claims affect solitude.

GA	Wilderness Inventory Polygon Name	Wilderness Inventory Polygon Number	Wilderness Inventory Polygon Acres	Recommended Wilderness Acres Alternatives B and C	Recommended Wilderness Acres Alternative D	Recommendation/Rationale
	Nevada Mountain[2]	UB10	51,027	39,345	44,702	Recommended with modifications in alternatives B, C, and D based on opportunities for solitude and ecological characteristics.

1 Inventory polygon is located on both the Upper Blackfoot and Rocky Mountain Range GAs.
2 Inventory polygon and recommended wilderness area is located on both the Upper Blackfoot and Divide GAs.

Appendix F. Landscape Visibility

Landscape visibility addresses the relative importance and sensitivity of what is seen and/or perceived in a given landscape. It is measured from what is seen from main travelways and use areas and from the distance the viewer is from the landscape being viewed.

- ***Travelways*** represent linear concentrations of public-viewing, including freeways, highways, roads, railroads, trails, commercial flight paths, rivers, canals, and other waterways.
- ***Use areas*** are spots that receive concentrated public-viewing use. They include visitor centers, vista points, trailheads, campgrounds, picnic grounds, swim beaches, marinas, resorts, ski areas, and other recreation sites. Use areas also include urban and suburban areas, towns, subdivisions, parks, or other public lands within or adjacent to the national forest.

Concern levels are a measure of the degree of public importance placed on landscapes viewed from travelways and use areas. Level 1 indicates a high concern, and level 2 is moderate.

Landscape visibility is mapped with GIS and is determined by distance zones, or the distance at which the landscape is being viewed. Table 1 displays a summary of elements of landscape visibility on the HLC NF, by GA. In addition to the features found on the GAs, there are also travelways on non-NFS lands, within 20 miles of the HLC NF (96 concern level 1 and 86 concern level 2).

Table 1. GA summary of landscape visibility

Geographic Area	Concern Level 1	Concern Level 2	Total Features
Big Belts	32	40	72
Castles	4	2	6
Crazies	0	2	2
Divide	21	25	46
Elkhorns	4	26	30
Highwoods	7	2	9
Little Belts	37	37	74
Rocky Mountain Range	79	13	92
Snowies	9	7	16
Upper Blackfoot	16	36	52
Forest Totals	**209**	**190**	**399**

The following series of tables provide a detailed list of all travelways and use areas currently found within each GA.

Table 2. Specific landscape visibility features in the Big Belts GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Atlanta Mule		X
	Avalanche		X
	Beaver Creek-Indian Creek		X
	Blacktail 4171		X
	Cabin Gulch-North Fork		X
	Camas		X
	Cave Gulch		X
	Confederate		X
	Duck Creek – Birch Creek	X	
	Gipsy Basin 8961		X
	Gipsy Lake Day Use		X
	Granger-North Fork		X
	Grassy Mountain		X
	Hanging Valley	X	
	Hellgate		X
	Magpie		X
	Microwave		X
	Missouri River	X	
	Pickfoot Spur #3 F1		X
	Refrigerator Canyon		X
	Smith River	X	
	Stove Camp Trailhead		X
	Sulphur Bar		X
	Trout Creek Canyon	X	
	US 12	X	
	Wagner Gulch		X
	York Road	X	
Lake/Pond	Edith Lake	X	
	Grace Lake	X	
	Hauser Lake	X	
	Hidden Lake	X	
	Holter Lake	X	
	Upper Baldy Lake	X	
	Upper Holter Lake	X	
River/Stream	Smith River	X	
Wilderness	Gates of the Mountains	X	
Campgrounds	Coulter	X	
	Deep Creek	X	
	Gipsy		X
	Pike Gulch	X	

Category	Name	Concern Level 1	Concern Level 2
	Skidway	X	
	Vigilante	X	
Documentary Site	Mann Gulch	X	
Fishing Site	Missouri River	X	
Lookout/Cabin	Bar Gulch		X
	Indian Flats		X
	Rillway	X	
	Thompson Station		X
Picnic Site	Gipsy		X
	Meriwether	X	
Trailhead	Big Log	X	
	Birch Creek		X
	Blacktail		X
	Boulder Lake		X
	Camas Lake		X
	Cave Gulch		X
	Edith Lake		X
	Hanging Valley	X	
	Hellgate		X
	Hidden Lake		X
	Hunters Gulch	X	
	Kentucky Gulch		X
	Magpie Meadows		X
	Nary Time		X
	Never Sweat		X
	Refrigerator Canyon	X	
	Spring Gulch	X	
	Stove Camp		X
	Thompson Creek		X
	Trout Creek Canyon	X	
	Wagner Gulch		X
	Willow Creek	X	

Table 3. Specific landscape visibility features in the Castles GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Bonanza Creek		X
	Castle Checkerboard	X	
	Fourmile	X	
	Fourmile		X
Campground	Grasshopper	X	
	Richardson	X	
Travelways	Forest Lake		X

Category	Name	Concern Level 1	Concern Level 2
Campground	Forest Lake		X

Table 4. Specific landscape visibility features in the Crazies GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Forest Lake		X
Campground	Forest Lake		X

Table 5. Specific landscape visibility features in the Divide GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Bison Mountain E1		X
	CDNST Contiguous	X	
	Chessman		X
	Continental Divide	X	
	Continental Divide Trail (2)	X	
	Grizzly Gulch		X
	Little Blackfoot		X
	Monarch		X
	Mount Helena	X	
	Mullan		X
	Ontario		X
	Park Lake (2 segments)		X
	Priest Pass		X
	Rimini Road		X
	Travis Creek		X
	Unionville	X	
	US 12 (2 segments)	X	
Lake/Pond	Park Lake	X	
Campground	Cromwell-Dixon	X	
	Kading	X	
	Moose Creek	X	
	Park Lake	X	
Documentary site	Charter Oak		X
	Masonic Site		X
Group campground	Park Lake	X	
Group picnic site	Park Lake	X	
Lookout/cabin	Kading Cabin		X
	Moose Creek Cabin	X	
Observation site	Mac Pass Vista	X	
Organization site	Lion’s Sunshine Camp		X
Picnic site	Tenmile Picnic Site	X	
Ski area (Nordic)	Mac Pass ski area	X	

Category	Name	Concern Level 1	Concern Level 2
Snowpark	Austin Creek		X
	Little Blackfoot		X
	Moose Creek		X
Specialized sport site	Prickly Pear Sportsman's Range		X
Trailhead	Larabee Gulch		X
	Lava Mountain		X
	Little Blackfoot		X
	Mac Pass CDNST	X	
	Monarch		X
	Mt Helena Ridge	X	

Table 6. Specific landscape visibility features in the Elkhorns GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Bullock hill loop		X
	Crow creek		X
	Crystal creek		X
	Elkhorn		X
	Indian creek		X
	Mcclellan cr		X
	Prickly pear		X
	South fork crow creek		X
	Tizer lakes		X
	Warm springs		X
	Weasel creek		X
	Weasel creek		X
	Weasel creek		X
	Weasel cut-across		X
	Willard creek		X
Lake/Pond	Glenwood Lake	X	
	Hidden Lake	X	
	Tizer Lakes (2)	X	
Lookout/Cabin	Eagle Guard Station		X
Picnic Site	Elkhorn Picnic Area		X
Trailhead	Crow Creek north		X
	Crystal creek		X
	Eagle basin		X
	Hall creek		X
	Jump off		X
	Longfellow		X
	Poe park		X
	Swamp creek		X
	Willard creek		X

Table 7. Specific landscape visibility features in the Highwoods GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Highwood Baldy		X
	N. Fork Highwood Creek	X	
	South Fork Highwood	X	
	South Fork Highwood		X
	Thain creek (2)	X	
	Thain creek camp spur	X	
Campground	Thain Creek	X	
Trailhead	North Fork Highwood	X	

Table 8. Specific landscape visibility features in the Little Belts GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Belt Park Connector	X	
	Daisy Road		X
	Divide Road	X	
	Divide Road		X
	Dry Fork Belt Creek	X	
	Dry Fork Belt Creek		X
	Dry Wolf	X	
	Dry Wolf		X
	Ettien Ridge		X
	Fawn Creek		X
	Haymaker Canyon		X
	High mountain	X	
	Hughesville		X
	Hwy 89	X	
	Jefferson Creek	X	
	Judith station	X	
	Lick creek	X	
	Lion creek		X
	Lonetree		X
	Memorial way	X	
	Memorial way (2)		X
	Middle Fork Judith river	X	
	Middle Fork Judith river		X
	Monument		X
	Monument ridge		X
	Moose creek		X
	Ruby-henn		X
	Sheep creek		X
	Smith river	X	
	Spring creek	X	

Category	Name	Concern Level 1	Concern Level 2
	West fork trombone		X
	Williams park		X
	Yogo creek	X	
River/Stream	Smith river	X	
Ski Area (polygon)	Showdown ski area	X	
Campground	Aspen	X	
	Basin Creek		X
	Dry Pole Canyon		X
	Dry Wolf	X	
	Hay Canyon	X	
	Indian Hill	X	
	Jellison Place	X	
	Judith Station	X	
	Jumping Creek	X	
	Kings Hill	X	
	Logging Creek	X	
	Lower Lion Creek		X
	Many Pines	X	
	Moose Creek	X	
	Russian Flat		X
	Spring Creek	X	
	Upper Lion Creek		X
	Whitetail		X
Fishing site	Sheep Creek Fishing Access	X	
Group campground	Dry Wolf Group	X	
Lookout/cabin	Calf Creek Cabin		X
	Dry Wolf Cabin	X	
	Hunters Spring Cabin		X
	Judith Station	X	
	Kings Hill Cabin	X	
	Monument Peak Lookout		X
Outhouse	Haymaker Outhouse		X
Ski area alpine (point)	Showdown	X	
Snowpark	Kings Hill Winter Recreation	X	
Trailhead	Balsinger Creek		X
	Daisy Dean		X
	Deep Creek	X	
	Holiday Camp		X
	Middle Fork Judith		X
	Memorial Falls	X	
	North Fork Hoover		X
	South Pilgrim		X

Category	Name	Concern Level 1	Concern Level 2
	Taylor Hills		x

Table 9. Specific landscape visibility features in the Rocky Mountain Range GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Arsenic Creek	X	
	Beaver - Willow Creek		X
	Benchmark	X	
	Blackleaf	X	
	Blackleaf Canyon	X	
	Blacktail-Landers Fork	X	
	Continental Divide Trail	X	
	County		X
	Dearborn River	X	
	Elbow Creek	X	
	Elbow Pass	X	
	Elk Calf Mountain	X	
	Elk Creek	X	
	Elk Pass	X	
	Falls Creek	X	
	Headquarters Creek	X	
	High Water 101	X	
	Jakie Creek	X	
	Kip Creek	X	
	Lee Creek-Sidney Creek	x	
	Mowitch Basin		X
	Muskrat Creek	X	
	My Lake	X	
	North Fork Dupuyer (2)	X	
	North Fork Sun (2)	X	
	North Fork Badger	X	
	North Fork Birch Creek	X	
	North Fork Red Shale	X	
	North Fork Teton (2)	X	
	North Wall	X	
	Open Fork	X	
	P. Prairie Low Water	X	
	Pike Creek		X
	Rock Creek	X	
	Route Creek Pass	X	
	Sawmill Creek Spur		X
	Smith Creek	X	
	South Fork Sun	X	

Category	Name	Concern Level 1	Concern Level 2
	South Fork Sun Low Water	X	
	South Fork Dupuyer		X
	South Fork Teton River	X	
	Straight Creek	X	
	Summit CG Cutoff	X	
	Sun River	X	
	Teton Pass Ski Area		X
	Two Med-Heart Butte	X	
	US 2	X	
	West Fork Teton	X	
	Wall Trail	X	
	West Fork Sun	X	
	White Rock		X
	Unnamed	X	
Ski Area (polygon)	Teton Pass Ski Area	X	
Boating site	Gibson Boat Launch	X	
	Home Gulch Boat Launch	X	
Campground	Benchmark	X	
	Cave Mountain	X	
	Double Falls	X	
	Elko	X	
	Home Gulch	X	
	Mill Falls	X	
	Mortimer Gulch	X	
	South Fork Sun	X	
	Summit	X	
	Van Dereit Memorial Pilots	X	
	West Fork	X	
	Wood Lake	X	
Horse camp	Benchmark Packer Corrals	X	
	Straight Ck Packer Corrals	X	
Lookout/cabin	Kenck Cabin	X	
	West Fork Cabin	X	
Observation site	Marias Pass Historic Site	X	
Picnic site	Wood Lake Picnic	X	
Ski area alpine (point)	Teton Pass	X	
Trailhead	Beaver	X	
	Blackleaf	X	
	Clary Coulee		X
	Elk Creek		X
	Green Gulch	X	
	Jones Creek		X

Category	Name	Concern Level 1	Concern Level 2
	Little Willow		X
	Middle Fork Teton	X	
	Mortimer Gulch	X	
	Ron Janikula	X	
	South Fork Sun	X	
	South Fork Teton	X	
	Straight Creek	X	
	Summit		X
	West Fork TXeton	X	

Table 10. Specific landscape visibility features in the Snowies GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Careless Canyon		X
	Crystal Lake	X	
	Little Snowies		X
	Niel Creek		X
	Red Hill Road	X	
	Red Hill Road		X
	Snowy Ridge		X
	Timber Creek		X
Boating site	Crystal Lake Boat Launch	X	
Campground	Crystal Lake	X	
	Timber Creek		X
Group campground	Crystal Lake Group	X	
Lookout/cabin	Crystal Lake Cabin	X	
Picnic site	Grandview Picnic Area	X	
Trailhead	Crystal Cascades	X	
	Ice Cave	X	

Table 11. Specific landscape visibility features in the Upper Blackfoot GA

Category	Name	Concern Level 1	Concern Level 2
Travelways	Alice Creek		X
	Aspen Campground	X	
	Aspen CG Spur (2)	X	
	Beaver Creek-Dry Creek		X
	Continental Divide Trail	X	
	Copper Creek		X
	Dalton		X
	Flesher	X	
	Highway 200	X	
	Hogum Creek		X

Category	Name	Concern Level 1	Concern Level 2
	Indian Meadows		X
	Indian Meadows Portal		X
	Keep Cool		X
	Lewis and Clark Pass	X	
	Lincoln Gulch		X
	Lower Hogum		X
	Marsh Creek		X
	Nevada Creek		X
	Nevada Ogden		X
	Sauerkraut		X
	Silver King B1		X
	South Fork Poorman		X
	Stemple Pass Road		X
	Sucker-Keep Cool		X
	Swede Gulch F1		X
	Unnamed		X
District Office Use Area	Lincoln District Office		X
Lake/Pond	Snowbank Lake	X	
Campground	Aspen Grove	X	
	Copper Creek	X	
Camping area	Alice Creek		X
Documentary site	Lincoln Ranger District	X	
Group campground	Aspen Grove	X	
Group picnic site	Aspen Grove	X	
Horse camp	Indian Meadows	X	
Interpretive site (admin)	Lincoln Ranger District	X	
Lookout/cabin	Cummings Cabin	X	
Trailhead	Alice Creek		X
	Arrastra Creek 482		X
	Dalton Mountain 404		X
	Dalton Mountain 467		X
	Dry Creek 483		X
	Flesher Pass 440		X
	Indian Meadows 481		X
	Marsh Creek 440 & 467		X
	Nevada Creek 466		X
	Sauerkraut Creek 401		X
	Snowbank Creek 418		X
	Stemple Pass 440		X
	Stonewall Mountain 417		X
	Sucker Creek 418		X

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